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LECTURE.

Friday, January 18th, 1867.

REAR-ADMIRAL SIR JOHN C. DALRYMPLE HAY, Bart., M.P.,
F.R.S., &c., &c.; in the Chair.

ON THE MODES OF DETERMINING THE ACCURACY OF ARTILLERY.

By Professor WM. POLE, F.R.S., Memb. Inst. C.E., late Member of
the Iron Armour Plate and the Armstrong and Whitworth Gun
Committees.

HAVING been for some years connected officially with Government investigations on Artillery and on Iron Defences, I have been frequently asked to give papers to this excellent Institution; but I have long hesitated, partly because it was inconvenient to enter upon matters open to much controversy while I was immediately engaged in official enquiries thereon, and partly because, being a civilian, I felt diffident in treating of subjects more properly belonging to the professions for whom this Institution was mainly intended.

It happens, however, that in the course of the enquiries I have alluded to, a subject has engaged my attention, which is not only independent of all controversies as to the merits of particular offensive or defensive systems, but is of a nature that a civilian may treat of without presumption.

In the investigations connected with the Armstrong and Whitworth Rifled Artillery, it became essential to contrive some good means of testing and defining the *accuracy* of guns, and as I could not find that the subject had ever been thoroughly treated of, I was led to reason it out for myself. The result of my investigations was communicated, now some years ago, to the Royal Artillery Institution at Woolwich, and was published by them in 1865. What I am now about to do is

to explain, orally, some of the reasonings and conclusions stated in that paper.*

Firing for Accuracy, whether with artillery or small arms, may involve two entirely separate and distinct things.

1. The determination of the personal skill of the individual using the weapon.

2. The determination of the qualities, as regards accuracy, of the weapon itself.

The first of these is the more popular subject, and it has, as we all know, been much developed of late by the volunteer rifle matches. It involves some interesting questions for scientific discussion, but it is no part of my business to speak of it here.

Our attention must now be confined to the other enquiry, and to the artillery branch of it, viz.: what is the best mode of determining the accuracy of a gun? Or having several different guns to be tried, what is the best mode of comparing their qualities as regards accuracy?

The simplest mode we can conceive of carrying out such a trial is to suppose a target erected, at the required distance, large enough to receive all the diverging shots; to place the gun, at every round, with its axis exactly in the same position, and to note the arrangement of the various shots on the target. In proportion then as these shots are closer, or more condensed and compact, the gun will be more accurate. In proportion as they are wider or more scattered, the accuracy will be less. But there are two serious objections to this simple process. In the first place, it is almost impossible to eliminate the element of *personal skill* in laying the gun. And, secondly, it is impracticable, at long ranges, to get targets *large enough* to comply with the necessary conditions; particularly with guns like the old smooth bores, whose shooting is inaccurate and wide.

For these reasons, the accuracy of guns, instead of being made the subject of special testing, has generally been *deduced* from another sort of trial, originally designed for a different purpose, namely the determination of the *range* which a gun will give, with a given loading, and a given elevation. To carry out this, a site is chosen where there is a long expanse of sand (level or nearly so) on which a straight line is drawn with stakes at different distances. The gun is then placed with its axis directed carefully along this line, and with the given elevation accurately determined by a gunner's quadrant, with spirit-level attached, placed in the bore. The gun is then fired, and accurate note taken of the spot where the shot fell in the sand. When several rounds have been fired, all under the same circumstances, the positions of the various marks are compared. The longitudinal differences shew what is called the *variation in range*; the positions on either side of the line shew what is called the *lateral deviation*, right or left, as the case may be.

* The extracts from the paper mentioned are published with the permission of the Royal Artillery Institution.—W. P.

It is easy to see therefore that as the shot are closer or wider apart, or in other words, as the *variations, in range, or laterally*, are less or greater, the gun may be pronounced more or less accurate. Thus the objects of the target method first mentioned, are attained by a mode more practical, and less open to objection. It amounts simply to placing the target *horizontally* instead of *vertically*, and to substituting for a personal aim, an instrumental determination of the position of the gun.

The rough estimate of the comparative accuracy of guns, deduced in this way, has answered very well for the old sorts of guns, where much delicacy of estimation was not necessary; but on the introduction of Rifled Artillery, it was soon seen that the accuracy was so important an element in the improvement, as to deserve more careful consideration.

The first scientific step in this direction was taken by Captain Andrew Noble, who, in 1859, published a paper in the Woolwich Artillery Proceedings, "On the application of the Theory of *Probabilities* to "Artillery Practice," the principal object of which was to point out a mode of defining and comparing the accuracy of ordnance of various kinds.

Retaining the principle of noting the position of the shots as they fall on a horizontal plane, Captain Noble shows it is possible to define a certain rectangle, supposed to be drawn on the ground where the shot fall; and which rectangle will denote the space within which it is an *equal chance that any shot will strike*; or (which is the same thing) within which *half the shot* will certainly fall in a very large number of rounds.

This is called the "probable rectangle," and the use of it is, that its *area* may be considered to be a measure, inversely, of the accuracy of the gun.

Thus a gun which, fired at the same range and elevation makes a "probable rectangle" half the area of that given by another gun, may be said to be twice as accurate; and so on.

The process by which Captain Noble calculated the probable rectangle, from the positions of the shots on the plane, was singularly elegant; and the new method of estimating accuracy received a wide sanction and adoption by the highest scientific authorities in artillery practice.

Since, however, the date of Captain Noble's paper, rifled artillery has taken a great and rapid development; its manufacture has been much improved, and its accuracy has been consequently much increased; and it has been found that the problems involved in the testing and determination of the comparative accuracy of different kinds of guns, are more intricate than was at first anticipated. Hence, Captain Noble's method, though perfectly correct and applicable as far as it goes, does not fully provide for all that the enlarged form of the problem requires.

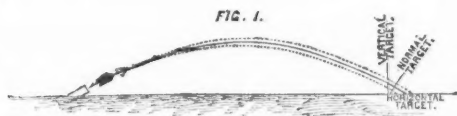
I have discussed the matter frequently with scientific artillerists, and have found such a difference of opinion on many important points, that I have been led to review the subject from the beginning; and while adhering generally to the mode of reasoning adopted by Captain

Noble, I have endeavoured to introduce some further elements which I think the subject demands.

I will proceed therefore to state in as clear and simple a manner as I can, the results at which I have arrived.

Premising that the accuracy of a gun must always be tested by a large number of shots fired, with the axis in a fixed direction, the first question is, as to the *position of the target* on which these shots shall be received and recorded.

There are three ways in which the target may be placed, and which will be at once explained by the following figure.



In the first place, the target may be a *horizontal* one, *i.e.*, the shot may be allowed to fall on some level surface, as is the usual way when practice is carried out on the sands.

Or secondly, the target may be placed *vertically*, which is the usual way, I believe, in small arm practice.

Or thirdly, it may be placed at right angles to the line of trajectory, so that the paths of the various shots (which may for this purpose be assumed parallel at that point) will be *normals* to the plane of the target. It is clear that this (although I am not aware that it has been before proposed) is the most correct position, as being the only one in which the errors of the shot in the direction of range are represented on the target without distortion. I call it the *normal target*, and propose throughout this paper, unless otherwise stated, always to consider the target as placed in this position.

It is right, however, to state that, for low elevations, the *vertical* target may practically be considered as coinciding with the normal one, the distortion being very small; and also that in many cases it is perfectly indifferent which of the three targets is used, inasmuch as having the positions of the shots on one, we can, if we know the *angle of descent* of the shot, easily adapt them to the others. Assuming as before the paths of the various shot, for this small distance, to be parallel, and the angle they make with the horizontal to be represented by θ , then we shall have, for errors in the direction of range,

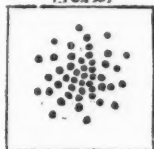
$$\text{Error on vertical target} = \text{error on horizontal target} \times \tan \theta \dots (1)$$

$$\text{Error on normal target} = \text{error on horizontal target} \times \sin \theta \dots (2)$$

The errors in the other direction may, without sensible error, be assumed the same on all.

Suppose then, a normal target to be set up, sufficiently large to catch all the shots, and a gun to be fired at it a great number of times, with its axis always in precisely a similar direction. Assuming for the present, as the simplest case, that there is no tendency to err more in one direction than another, we shall find the marks distributed on the target somewhat in the following manner; that is clustered round a central point in numbers gradually diminishing as their distance from this point becomes greater.

FIG. 2.



The first thing to determine is the position of the central point. This is not directly shown by the shooting; indeed, it is quite possible that it may not exactly coincide with any one of the shots. It must consequently be found by calculation, and the laws of probabilities teach us that it should be in that position where the *sum of the squares of the distances from it to the various shots, will be a minimum*; and this is known to be the property of the centre of gravity of all the shots, which is easily found by well known rules. The point thus found is then, most probably,* the true centre where the gun, if it had *no error*, would deliver all its shot, and is therefore the point at which it may be said to be aimed. It is a very important element in all calculations of accuracy, and I shall call it the *centre of impact*, or *point of aim*.

Having determined this point, let us now endeavour to form some idea of the accuracy of the gun.

Perhaps the most obvious mode of doing this, would be to adopt a plan often used in comparing the accuracy of small arms, *i.e.*, to measure the linear distance of each shot from the central point (or what is called its *absolute error*); to add the whole together, and to divide by their number. The quotient will give a quantity which is popularly called the "*figure of merit*," or which may be more definitely termed the *mean absolute error*. This quantity will undoubtedly give some idea of the accuracy of the gun, for when we find the "*figure of merit*" to be less, we may rightly infer the accuracy to be greater, and *vice versâ*.

But suppose we are engaged on a problem which requires us to go farther, and to define *how much* better one gun is than another. We have no ground whatever for assuming the degree of accuracy to be proportional (inversely) to the mean absolute error. It may vary, for

* This probability being greater, in proportion as the central point is deduced from a larger number of rounds.—W. P.

aught we know, as the square, or the cube, or the square root, or in no definite proportion at all. We can only say that a gun that makes a small figure of merit is a better gun than one which makes a large one; *how much* better, we have no right to pronounce without further reasoning.

To guide us in this reasoning, we must enquire, what do we mean by the accuracy of a gun? How do we define the term? To be enabled to answer this question, we must propose another. What is the object of accuracy? What use or duty of a gun is accuracy intended to promote?

To this there can be but one answer. Clearly the duty of a gun is to *hit the object aimed at*; and that gun will be most accurate which best performs this duty. And hence the *degree* of accuracy of a gun is evidently measured by the degree in which it promotes the efficiency of the gun in this respect. For example, if two guns are each fired 100 rounds, at a small object, under precisely similar circumstances, and one gun hits it 10 times, and the other 20 times, it is matter of common sense that the second gun will be twice as useful;—twice as well adapted to its duty;—in short, *twice as accurate* as the first one.

Now the number of times a gun will hit its object, *ceteris paribus*, in a large number of rounds, is equivalent to what mathematicians call the *probability* of hitting it, and hence we arrive at the conclusion that by the accuracy of the gun is meant simply the *probability* of its hitting the object at which it is aimed.

It is however necessary to the correctness of the definition that the object should be of *small size*; for of course if it were very large, a bad gun would be almost as likely to hit it as a good one. Any dimensions not exceeding the mean error of the best guns will answer the purpose in a practical point of view; but the principle becomes more correct when the object is reduced to an *indefinitely small area*, covering what we have called the centre of impact, or point of aim.

And hence the *probability of hitting this small area*, is the true scientific definition of the accuracy of the gun.

If now we turn back to our attempt to determine the accuracy of a gun by its "figure of merit," or mean absolute error, we shall at once see that this quantity of itself tells us nothing to the purpose; for it only gives the degree of average *proximity* to the centre, which by no means corresponds with the probability of hitting it. It is indeed possible, in some cases, to *deduce* the probability from the mean absolute error;* but as we shall hereafter show that there is a better method of finding this probability, of much more general application, we need not consider this "figure of merit" system further. It is merely a rough popular mode of estimation, devoid of any scientific

* If the error of the gun is equal in all directions, and l = mean absolute error, deduced quadratically, then the probability of hitting an indefinitely small circle of radius = dx , covering the centre of impact, will be = $\frac{1}{l^2} dx^2$, that is, the accuracy varies inversely as the *square* of the figure of merit. When the error is much greater in one direction than another, as is generally the case with ordnance, the method fails.—W. P.

basis, and its use is unjustifiable where any scientific accuracy is required.

It is, however, worth while to add, that this system fails, like that of the probable rectangles, to give any means of comparing the accuracy of guns tried at different ranges. For it is evident that a gun fired at a long range will give a much greater figure of merit, and therefore appear much more inaccurate than one fired at a shorter range, even though the real accuracy of the first gun might be the greater of the two.

But there is a consideration not yet alluded to, which has an important bearing on the point now under discussion.

In describing the case above investigated, we assumed at the outset, for the sake of simplicity, that the gun had no tendency to err more in one direction than in another, and therefore deposited its shots in a circular form round the central point of impact, as shown in fig 2.

Now this is very seldom the case, for both theory and experience show that there is almost always a greater tendency to err in one direction than in another. It is true that many causes of error tend equally in all directions; but there are two important ones, almost always present in artillery practice, which act in one direction only. The first is, the variation in the initial velocity of the shot, caused chiefly by irregularities in the strength or burning of the powder, and which tends to produce *vertical* error on the normal target, or what is called "error in range" on the ground. The second is the disturbance of the position of the gun by the commencement of its recoil, which also acts in the same direction as the former one, the first movement of the axis being almost exclusively in elevation.

These two causes combining together, will tend to magnify the vertical errors on the normal target, and so to produce an elongated cluster somewhat like this figure.*

FIG. 3.



We have thus two different sorts of errors.

On the normal target they are simply errors in the *vertical* and *horizontal* directions respectively, as already explained.

* This peculiarity of figure in the practice of guns deserves more investigation. It might be easily inferred from the probable rectangles, if the angle of descent were ascertained; or the adoption of the "test target" system which I propose hereafter, would show it as a part of the process itself, without trouble. I am informed by Captain Noble that in some very carefully made experiments with a 12-pr. Armstrong gun, the variation in the "angle of departure" was about five minutes.—W. P.

But on the ground, or in actual practice, they resolve themselves into what are called,—

1. Errors in range.
2. Lateral deviation.

The question has often been raised, which of these is the more important? but the differences of opinion among artillerists on this point, are so wide, as to admit of no satisfactory answer to it being given.

Some will consider error in lateral deviation, of more importance than in range; others just the contrary.

And this is only natural, when we consider the variety of objects for which, and the variety of ways in which, artillery may be used.

In firing, for example, at lines of men in front, lateral error is of less importance than error in range; but in firing at columns, or at the same lines in flank, the contrary is the case.

Also, in firing from a fort at a ship approaching or leaving, error in range is of less moment than lateral error; but in firing at her broadside on, the reverse is true.

Although, therefore, we cannot introduce, into our calculations of accuracy, any satisfactory comparative estimation of the two sorts of error; yet, the fact of their separate existence is very valuable for our purpose, inasmuch as it naturally points to another method of estimating the positions of the shot on the target, much more simple and appropriate than the clumsy method of taking their absolute distances from the centre.

This is the plan generally followed in mathematical calculations, whenever the positions of several points on a plane surface have to be considered, and called the method of *rectangular co-ordinates*, the application of which to the case in question is exceedingly simple and easy.

Having found the probable mean centre of impact as before (by taking the centre of gravity of the whole of the shots registered) draw through it a vertical and a horizontal line, as in the following figure.



Then, taking any shot *a* as an example, its position will be accu-

rately defined by two co-ordinates, x and y , drawn parallel respectively to the horizontal and vertical lines before mentioned. We will call the distance y , the *vertical error* of that shot, and the distance x , its horizontal error.

Suppose next we wish to find the *mean errors* in both directions. The most simple and natural mode is to add all the vertical errors together (both above and below, without regard to sign), and to divide by the total number. This will give the mean vertical error; the mean horizontal error may be obtained in the same way. These mean errors are said to be determined *lineally*. They correspond with the "*écart moyen*" of the French artilleryists, and we may denote them, in the French notation, by the symbols K and H respectively. So that

$$H = \text{mean horizontal error (determined lineally)} = \frac{\Sigma x}{n} \dots (3)$$

$$K = \text{mean vertical error (determined lineally)} = \frac{\Sigma y}{n} \dots (4)$$

But the term *mean error* is somewhat vague. A mean quantity is not necessarily a simple arithmetical mean; for the way it is advisable to find it, often depends on the purpose for which it is to be used. In this case, the whole problem being one of probabilities, mathematical considerations teach us that we shall have a greater chance of being correct, if we estimate the mean error in another way, viz., by adding together the *squares* of the separate errors, dividing by the number, and taking the square root of the quotient. The mean errors thus obtained are said to be determined *quadratically*. They correspond with what the French call the "*moyen écart*," and may be represented by h and k respectively,* thus

$$h = \text{mean horizontal error (determined quadratically)} = \sqrt{\frac{\Sigma x^2}{n}} \dots (5)$$

$$k = \text{mean vertical error (determined quadratically)} = \sqrt{\frac{\Sigma y^2}{n}} \dots (6)$$

Now having these mean errors, taken from a sufficient number of shots upon a normal target, we have all that is necessary for determining the accuracy of the gun; and, moreover, they possess the great advantage over the single absolute distance plan, that they show, of themselves, the tendency of the gun to error in the two directions respectively. It remains to point out how the probability of hitting the centre of impact (which we have stated to be the

* If the number of shots is not very large, it has been shown by Captain Noble that it will be more correct to divide each of the mean errors by $n = 1$.

If a very large number of rounds is taken, it is found that

$$\frac{h}{H} \text{ or } \frac{k}{K} = \sqrt{\frac{\pi}{2}} = 1.25 \dots (7)$$

correct definition of the accuracy of the gun) may be deduced from them.

In order to simplify the expressions used in the following somewhat complicated formulæ, we will make

$$p = \frac{1}{h\sqrt{2}} \dots\dots\dots(8)$$

$$q = \frac{1}{h\sqrt{2}} \dots\dots\dots(9)$$

p and q being called the "measures of precision" in each direction.

Assuming that there are no abnormal causes of error tending to produce special variations, the laws of probabilities give us the following theorem applicable to this case.

Taking first the horizontal errors; let us call an error to the right +, and an error to the left -.

Then the probability of a shot striking at a horizontal distance = + x (see fig. 4), to the right of the centre line (or to speak more correctly between the distances x and $x + dx$), will be

$$= \frac{p}{\sqrt{\pi}} e^{-p^2 x^2} dx \dots\dots\dots(10)$$

And, similarly, for the vertical errors; let the errors above the centre be called +, and those below -.

Then the probability of striking at a distance = + y above the centre, will be

$$= \frac{q}{\sqrt{\pi}} e^{-q^2 y^2} dy \dots\dots\dots(11)$$

The probability therefore of hitting a very small area of the target, situated as at a on the figure, will be the multiple of the two probabilities on which it depends, *i.e.*,

$$= \frac{pq}{\pi} e^{-(p^2 x^2 + q^2 y^2)} dx dy \dots\dots\dots(12)$$

Now suppose this very small area to be situated as at b , *i.e.*, close to the central point, making x and y each = 0. The probability of hitting it, which may be taken in practical language to be the same as that of hitting the centre of the target, will be

$$= \frac{pq}{\pi} dx dy \dots\dots\dots(13)$$

and substituting for p and q their values in equations (8) and (9), the probability becomes

$$= \frac{1}{2\pi hk} dx dy^* \dots\dots\dots (14)$$

From which we see that the *accuracy of a gun is inversely proportional to the product of the mean vertical and horizontal errors, i.e.,*

$$\text{Accuracy of gun} \propto \frac{1}{hk} \dots\dots\dots (16)$$

Supposing, therefore, several different guns to be on trial, we have here a means, scientifically correct and perfectly practical, of defining the accuracy of each, and of comparing them, in this respect, with each other.

But, to render the comparison accurate, they must all be tried *at the same range, or nearly so.*

For, of course, the probability of hitting a certain point, even with the same gun, must be much less at a longer than at a shorter range, and hence it is impossible to compare the expressions of accuracy obtained at different ranges.

I am not aware that any method previously proposed has provided for this case, but after a good deal of consideration I have suggested one which appears to me to answer the purpose. It is exceedingly simple, and is founded precisely on the same principles as the method above described, being merely an extension of them to a form of the problem somewhat more practical, and of more general application.

I propose to measure the accuracy of a gun by the *probability of its hitting*, not an indefinitely small area as hitherto assumed, but an *actual target*, to be called the *test target*, whose dimensions shall be *proportioned according to the range at which it is to be used*, in a mode hereafter explained.

For example: let it be required to compare the accuracy of two guns, one firing at 2,000 yds. range, the other at 3,000 yds. Let the former be directed at a target one yard square, and the latter at one *larger* in the proper proportions. Let 1,000 rounds be fired from each gun, aim being always taken precisely on the centre. Then if one gun hits the target 100 times (which a good rifled gun will do) while the other hits only 90 times, I propose to denote their relative degrees of accuracy by the direct ratios of these numbers, or as 10 to 9.

This mode approaches quite near enough to theoretical accuracy, while it has the advantage of being a kind of test of the most simple, practical, and intelligible nature, and one indeed whichartil-

* Or making $dy = dx$; we may say that the probability of hitting a very minute square covering the centre of impact, whose side = dx , will be $= \frac{1}{2\pi hk} dx^2$. For a circle whose diameter = dx , the probability will be

$$= \frac{1}{8hk} dx^2 \dots\dots\dots (15)$$

lerists and riflemen are perfectly familiar with in every-day practice. And it has further the merit of being applicable to practice at any range.

I proceed to show, that in order to apply this method, it is not at all necessary that the guns should actually be fired at the targets as above supposed. It is quite sufficient that the practice be carried on in the usual way, by firing the guns at certain elevations, and registering the places of the shot as they fall upon the ground, precisely as usual. All the rest is matter of calculation, as from these data, the number of shot which *would* hit the targets, if the guns were really fired at them, can be deduced with even greater correctness than by actual trial. The only addition necessary to the usual elements given, is the determination of the *angle of descent* of the shot, which is by no means a difficult matter.

The most convenient form for the test target is a square: it must be supposed to be placed normally, and with its centre precisely corresponding to the centre of impact.

Let the length of its side, as hereafter determined,

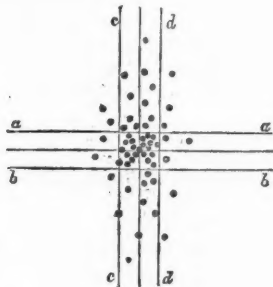
$$= a.$$

The mean errors in deflection and range, having been determined (quadratically) from the shots on the ground, must then be applied to the normal target, the former unchanged, giving our quantity h ; the latter multiplied by the sine of the descending angle to give k . The problem is then reduced to finding the probability of hitting a square target whose centre coincides with the centre of impact, and whose side

$$= a.$$

To find this we must revert to the reasoning in Art. 21.

Let the following figure represent the group of shot referred to the normal position, and let the small square in the centre formed by the intersection of the four lines of a , b , c , d , represent the size of the *test target* we are now considering.



Taking first the errors in a horizontal direction, we have seen

(Equation 10) that the probability of any shot falling between the distances x and $x + dx$ to the right of the centre, will be

$$= \frac{p}{\sqrt{\pi}} e^{-p^2 x^2} dx,$$

whence the probability of any shot falling between the centre and any distance $= \frac{a}{2}$ will be

$$= \frac{p}{\sqrt{\pi}} \int_0^{\frac{a}{2}} e^{-p^2 x^2} dx, \dots \dots \dots (17)$$

And, by the symmetry of position, to the right and left of the centre, the probability of any shot falling within the vertical band formed by the lines c and d (being a distance apart $= a$) will be

$$= \frac{2p}{\sqrt{\pi}} \int_0^{\frac{a}{2}} e^{-p^2 x^2} dx, \dots \dots \dots (18)$$

Similarly, taking the errors in a vertical direction, we shall find the probability of a shot falling in the horizontal band comprised between the lines a and b

$$= \frac{2q}{\sqrt{\pi}} \int_0^{\frac{a}{2}} e^{-q^2 y^2} dy, \dots \dots \dots (19)$$

And, since the probability of two events concurring is equal to the product of the probabilities of each separately, we find that

The probability of hitting the test target, and consequently the ACCURACY OF THE GUN, is

$$= \frac{4pq}{\pi} \int_0^{\frac{a}{2}} e^{-p^2 x^2} dx \int_0^{\frac{a}{2}} e^{-q^2 y^2} dy. (20)$$

the value of which for any given case may be easily found by tables constructed for the purpose.

It only remains to explain how the *size of the test target* should be determined for different ranges. This would require some little care at the outset, but being once correctly fixed, all difficulty ends. The conditions necessary are two-fold: first, that it shall be sufficiently small; and secondly, that its dimensions shall vary, for different ranges, according to what we may call the *march of precision* of the best guns; so that a gun of the most perfect kind we know may have an equal probability of hitting it at all ranges.

Our ballastic knowledge is not sufficient at present to enable us to determine this condition *à priori*, but it might easily be deduced from good records of the practice of the best guns, and a table might thus be constructed giving the size of test target suited to different ranges

of fire. This might further, if necessary, be easily corrected from time to time as further knowledge was gained.*

This method of determining the accuracy of a gun gives a certain degree of preference to *compactness* of fire. If two guns firing at the same range, delivered their shot on the target in the manner represented by figures 2 and 3 respectively, both covering an equal area, but differing in the dispersive form, most artillerists would give the preference to figure 2, in which the fire was most *compact*. The test target system will show this advantage, as the probability of hitting a square target of definite size will be greater in the first case than in the second.†

I will now state the practical rule by which the "test target" method of determining the accuracy may be applied; having given, the fall of shot on the ground, and their average descending angle. It will be seen that it is very simple and easy.

(1) Find the mean range, and take out from the target table the length of the side of test target corresponding thereto, which call a .

(2) Find the mean error‡ in range, and multiply it by the sine of the descending angle. Call this k , and find the value of $\frac{a}{k}$.

(3) Find similarly the mean error‡ in lateral deviation, call this h , and find $\frac{a}{h}$.

(4) Having these two values, the accuracy of the gun may be found by simple inspection of an accuracy table to be constructed for the purpose.

* According to the information I at present have, I believe that the side in yards, of a test target, which will take one-tenth of the shot of the best guns, will be about

$$= \frac{r^{\frac{2}{3}}}{110,000}, \text{ where } r = \text{range in yards.} - \text{W. P.}$$

† The difference will increase with the size of target used at any given range. The disadvantage of want of compactness of fire is also shown by the "figure of merit" system, but in a much exaggerated degree.

‡ To be determined quadratically. If determined lineally they must each be multiplied by 1.25. — W. P.

Ebening Meeting.

Monday, January 21st, 1867.

REAR-ADMIRAL A. P. RYDER in the Chair.

NAMES of MEMBERS who joined the Institution between the 1st and 21st January, 1867.

LIFE.

Dawson, Hon. R. M. W., Lieut. Gren.	Sibthorp, F. R. Waldo, Lt. Col. Unatt.
Gds. 9l.	9l.

ANNUAL.

Wood, Herbert W., Capt. R.E. 1l.	Frankland, Colville, Capt. 103rd Roy.
Strange, Alexr., Major 14th Regt. 1l.	Bo. Fus. 1l.
Waugh, Sir Andrew Scott, Major-Gen., ret. f. p. R.E., F.R.S. 1l.	Hire, Henry W., Capt. R.N. 1l.
	Fletcher, T. C., Capt. R.A. 1l.
	Grubb, Alexr., Lieut. R.A. 1l.

BREECH-LOADERS, WITH REFERENCE TO CALIBRE, SUPPLY AND COST OF AMMUNITION.

By Captain J. H. SELWYN, R.N.

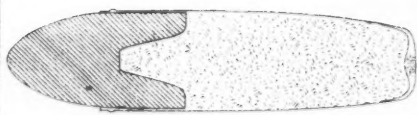
War Office, Oct. 22, 1866.

"To Gunmakers and others."
"THE Secretary of State for War is desirous of receiving proposals
"from gunmakers and others for breech-loading rifles, either repeat-
"ing or not repeating, which may replace the present service rifles in
"future manufacture."

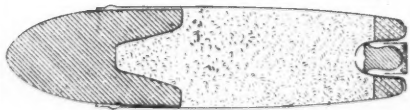
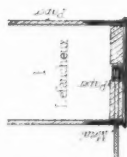
Such is the heading of the invitation addressed by the Government to all whom it may concern, and being myself one of these, I have thought that here, in the Royal United Service Institution, I might contribute to the general chances of success by reading a paper; for the discussion on it may perhaps establish certain bases of action, the want of which at present renders it difficult, if not impossible, for any one to invent, much more manufacture a satisfactory arm. If indeed

we knew what calibre to choose or what cartridge to select, if the form of groove and the ratio of its spirality were not equally left undecided, we might think ourselves able to produce something that should fulfil the other conditions necessary in a perfect breech-loading rifle for infantry, at least we could certainly surpass without the slightest difficulty the so-called "Snider Rifle," (Plate I) which is, in the circular, proposed to us as a model. But who can compete in a race where important conditions are not precisely stated, and where the winner might be told he was disqualified because he had not got on high heeled boots, or his horse had not been shod with gold; neither of which conditions were previously within his knowledge. But whether or no, all these points are said to be "optional," and we must seek for ourselves, the explanation of that word "optional." It will be evident from even a cursory examination of the subject, that on the calibre must depend a considerable proportion of the other conditions, and therefore the very first question to be solved is this, what is the best calibre of bore, and consequently what will be the size and shape of bullet? I confess that I incline to .500 of an inch, as the best compromise between unnecessarily large and unwisely small bullets. Now as the bore of a breech-loading gun should always be smaller, over the lands of the rifling than the bullet, that is that the .500 of an inch should be measured from the bottoms of the grooves, it follows that the calibre as usually measured will be something less than .500, less in fact by whatever may be the depth of the grooving. In a breech-loading gun the idea of expanding bullets is unnecessary and ought not to be retained, unless it be merely a consequence of the fulfilment of other important conditions. No alteration of the shape of the projectile should be allowed to take place, whether by upset or expansion, if we wish to obtain regular shooting. It is, however, a not unimportant consideration, whether, unless we can secure a materially lighter bullet, it is worth while for the sake of long range alone, to alter in any way the present calibre. Long range for military purposes will lead to the waste of much ammunition. I doubt whether it will ever decide the fate of a battle. A change of calibre will introduce still greater confusion and difficulty where there is too much as it is, *i.e.*, in the supply of ammunition; besides the teaching of the late war in Germany, does not seem to be favourable to the theories of those who advocate the small bullet. If indeed we could by using a smaller calibre, materially diminish the weight to be carried, this would be an object worth attaining, but the small-bore bullet weighs as much as the Enfield when made of such a shape as to give its best results, and if lightened by admixtures of substances of less specific gravity, its range and penetration cannot be so great. There is indeed a form of bullet which seems likely to meet most of the objections that have hitherto prevented us from obtaining a perfect projectile. This is the Macintosh tubular or hollow projectile, of which I shall speak more fully in its place. The first question I should wish to be solved by the discussion is this, if we reduce our calibre with what view are we to do so? Is it to be done for the sake of a long range, which Military and Naval Officers will alike tell you is a secondary consideration in

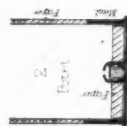
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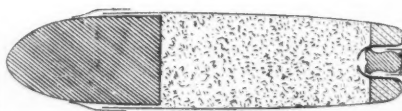
Selwyn Cartridge
modified



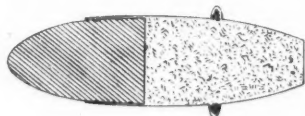
Selwyn Cartridge
as now made



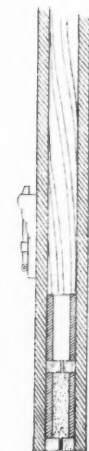
Selwyn Cartridge
after explosion



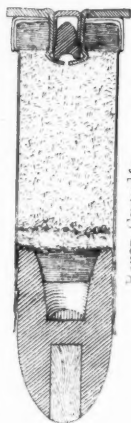
Selwyn Small Bore
(.4 inch) Cartridge



Foulmeyer Cartridge

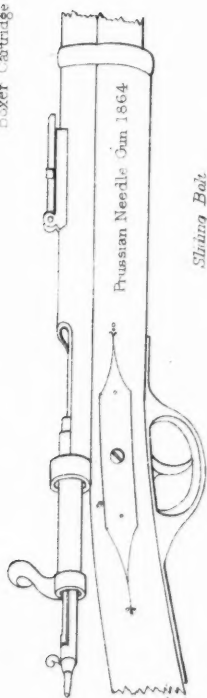


Madantosh Tubular Projectile Cartridge Case



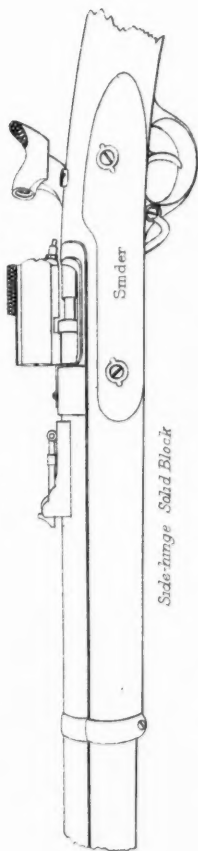
Boxer Cartridge



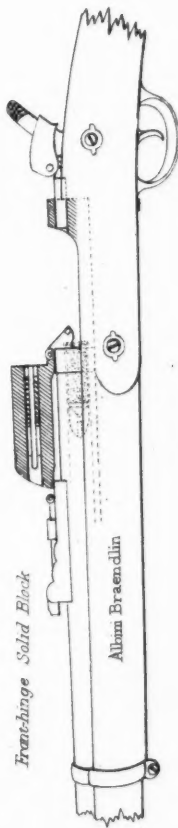


Prussian Needle Gun 1864

Sliding Bolt

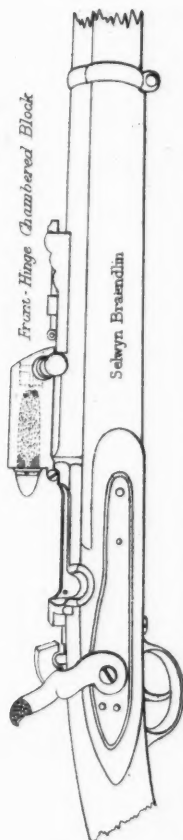


Side-hinge Solid Block



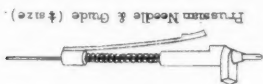
Front-hinge Solid Block

Albin Braendlin



Front-hinge Chambered Block

Salwyn Braendlin



Prussian Needle & Guide (1/2 size)

the field, or for the lightening of the bullet in order to make it possible for the soldier to carry more ammunition. Secondly, how far can we go without reducing the efficiency of the ball at those ranges where it is most generally used in warfare, unless preserving the same outside diameter, we reduce the specific gravity by admixture with tin, wood, or air, as in a bullet more or less hollow. I am myself in favour of the latter.

It will be useful to recollect that the whole question of grooving has been re-opened by the use of breech-loaders, and that a fine grooving which would have speedily been inoperative by reason of fouling in a muzzle-loader, will probably give excellent results in breech-loading guns, where the bullet is at once forced into the grooves through its whole length by the explosion; and fouling is scarcely perceptible after any number of rounds if the lubrication is properly managed.

The question as to supply of ammunition in the field comes next in order, but this is so closely united to the question of calibre, that what answers one will solve the other. Nevertheless, we may observe that the mode of supplying ammunition in the field must vary with the nature of transport in different natures of ground. Men in mountainous countries, mules, horses, or elephants in less difficult circumstances being used as each is found available. Although it is said that no soldier, during the late campaign in Germany, was short of cartridges with an original supply of 60, this must not be taken for a rule, seeing that our own experience in the Crimea and elsewhere has shown conclusively that it is sometimes insufficient, and that 100 or 120 cartridges would be more desirable as the normal number to be carried by the soldier. In most forms of cartridge now known, the smaller the calibre, the more unhandy and expensive is the cartridge on account of its increased length.*

I now come to the cost of the cartridge, and this is of the first importance, seeing that with a difference in this respect of £1 per thousand, the fourth thousand will have cost more in excess than the best guns which can be made for about £3 10s. or £3 18s., and this will go on telling during the whole life of the gun, a specially interesting fact to volunteers, who probably now fire more ammunition in the year than our whole army, and what is more, have to pay for a good deal of it themselves. We may take the average price of powder and ball for an Enfield rifle at 35s. to 40s. per thousand cartridges; and the cost of each description of case, is of course the difference between this and the selling price of the cartridge per thousand. The cartridge now used for the converted Enfield is sold by Messrs. Eley, at

* It seems to us Naval men, that a great economy of the weights a soldier now carries, might be made by improvements in dress and accoutrements; that a cartridge box is an absurdity only inferior to the old shako, and that thus the men may be enabled to carry 120 cartridges, which would weigh about 12 lbs. No system of supply, is equal to that of carrying what is essential, about one. We must also recollect that old Brown Bess weighed 12 lbs., the modern rifle, only 9 lbs.; and as the 60 cartridges now carried weigh about 6 lbs., or 10 to the pound, we only ask for 3 lbs. more to be carried than the regulation weight of arm and ammunition during the Peninsular War.—J.H.S.

no less than £5 per thousand. I cannot say what it may be quoted at at Woolwich or Enfield, seeing that at the Government establishments, and in Government calculations generally, nothing is charged for capital, salaries, or manufacturer's profit. But £5 per thousand is an almost prohibitive price to the Volunteer of moderate means, and will sadly curtail his inclination for practice at the targets. The composite cartridge known as the "Boxer," is seldom capable of being refilled, and therefore the whole of the first cost must be charged against it. The great desideratum is a metallic cartridge which shall weigh no more than, and cost as little as, the old powder and ball, while possessing that immunity from damage by fire or water which is the characteristic of the copper-cased cartridge, and with this, that the exploded case should either be easily extracted, or that there should be no need for this process. I have here an invention which seems likely to fulfil these conditions, and in addition to them, possesses some most valuable qualities of long range and low trajectory. Having made these preliminary remarks, I propose to classify the different forms of cartridge and bullet; to bring before you the peculiar properties of each; and then to pass in review, in a similar manner, the best known arms from which they are to be fired.

The cartridges for breech-loading fire-arms may be broadly divided into three primary classes:—

First, the paper or skin cartridge.

Second, the composite cartridge.

Third, the metallic cartridge.

The paper or skin cartridge may, or may not be self-igniting, its price is about 40s. or 45s. per thousand, it is easily destructible by wet or fire and liable to be exploded by shells, when in ammunition reserve waggons. The Prussian needle-gun cartridge and the Mont-Storm skin cartridge are good examples of this class. It will probably disappear from warfare, and does not therefore require further notice.

We now come to the composite cartridge and our examples may be taken from the sporting cartridges, whether central-ignition, or pin, and that used for the converted Enfield called "Snider's" rifle.

We have here an enormous step in advance. The breech-loader, which before the introduction of these cartridges, was liable to the serious objections of bursting, gas escape, and fouling, at once becomes a safe and cleanly weapon. But in both of those referred to, and indeed in all cartridges that are indestructible by the explosion, a serious difficulty has to be met, viz., that of the withdrawal of the emptied case. This is in most cases accomplished by an extractor, a special appliance moved by hand, by springs, or by levers, which cannot of course act properly on any cartridge, that by sticking, offers unduly increased resistance, or by bending or breaking, offers too little. These disadvantages have already been seriously felt in many cases with both the composite and metallic cartridges, and any weakness of the cartridge is sure to make itself evident in this direction. The composite cases are not all as yet, though probably they easily might be thoroughly protected from the effects of a damp atmosphere, and this

leads to "sticking" more often than would otherwise take place. The selling price of these cases, empty, ranges from 60s. per thousand (military Boxer's) to 40s. and 20s., for sporting purposes; but a well known gunmaker has told me that the paper cartridge with metallic base, for military purposes, can be sold *filled* for 55s. per thousand. This seems a very low price, being only 15s. per thousand for the cases! and it ought to be good news for sportsmen and Volunteers if correct. In both the sporting and military composite cartridge, the ignition is effected either by central fire or pin; the central fire is in almost every respect, the preferable mode, and though it is true that the pin cartridge shows when the gun is loaded, which the other does not, yet it is easy to meet this objection, and it has been done by various contrivances; while a considerable gas escape which takes place round the pin is a much more important fault. For a military gun of moderate bore, a serious loss of space or increase of length, is the result of using a material like paper or pulp to which a certain thickness is necessary to be given, and although this is not the case in the brass roll cartridge, yet its want of solidity is an almost equivalent evil. This latter cartridge must also be more expensive to manufacture than simple metallic ones, and it is hard to understand what advantage it possesses above the less complicated American cartridge. I look upon the withdrawal of the empty cartridge case as quite as easy in all cases, whether a rolled sheet or a stamped cylinder is used, both expand to the form of the barrel. This is always coned out to the rear in the chamber, a practice which can only be defended as being necessary for extraction, and one that is directly opposed to all the laws of gunnery, but it no doubt does permit the withdrawal of the exploded case with a facility not otherwise attainable in this form of cartridge.

I will now pass to the third class of cartridges, those constructed wholly of metal and stamped up from blanks by machinery. There is a simplicity and speed of fabrication in these that is very attractive to the manufacturer and I shall have some curious varieties to show you. The strength and non-liability to injury by fire or water, together with the fact that in some forms the exploded cases can be many times refilled, and at last are saleable as old metal, will tend also to make them favourites with the shooter. I believe the origin of the American form which is the best known, was the breech-loading bullet cap of the saloon pistol and rabbit rifle. However this may be, the Americans seem to have at once adopted it for all their breech-loading guns, and although not the cheapest, the metallic is certainly the most durable cartridge under all conditions. Even the white ant could do it no harm and powder may be ignited all round it with impunity, whilst if the bullet and cap be well waxed, it may be kept in water for months and then fired with perfect certainty. The American metallic cartridge is generally, if not always, ignited by fulminate placed in the rim surrounding the base, but this system has the defects of causing an excessive quantity of fulminate to be used which sometimes blows through the base and gives dangerous gas escape, at the same time that it renders difficult or

prevents the withdrawal of the case by the extractor. I have been told by an American that the price of these cases would be about £2 per thousand, the cases with the rim priming are difficult to refill, and would be worth, as old metal, about 10s. per thousand.

Modifications of this form have been made in America, but are not I believe now in use. In this country the Poulteney cartridge, a double cone, and Mr. Clark's steel or iron cartridge are variations on the common form, but I cannot say to what trials they have been subjected. There is also one that is known by my name, which has the peculiarity that it is self-extracting by the expansion of the copper into depressions or annular grooves in the barrel, and that by reason of its conical form the *primed cases* will pack one inside the other, enabling 6,000 to be stowed in one cubic foot, whereas only about 1,800 of any others can be so stowed. It is also considerably cheaper to manufacture than cylindrical copper cartridges and can be refilled five or six times. The next metallic cartridge to which I shall draw your attention is a novel and very ingenious invention of Mr. Macintosh's. Here the case is of lead, tubular in shape, open at both ends, having the weight and diameter of an Enfield bullet, but 1.77 inch in length. A wad of wood or other material carrying the means of ignition is secured by a covering of thin felt behind the tube, it is then filled with powder and the cartridge case has become also the bullet and a very efficient bullet too, having a point blank range of 400 yards, and an extreme range much greater than the ordinary projectiles owing to the diminution of the area of resistance. By reference to the diagram (Plate I.) you will see that these projectiles are fired by first shaking out the powder from one of them and placing it in the gun with its wad; next, another is inserted *with the powder*, and this pushes the first up the barrel. The breech being now closed and the gun being fired as usual, the first inserted bullet is driven out, and the second remains ready to be in its turn pushed forward, from having been a cartridge case to become a projectile. Some experiments have been made and others are in progress, and I shall be happy to communicate the results on some future occasion. You will see that although I hoped I had made as good, if not a better, metallic cartridge than any other, yet if this be a true system, no other metallic cartridge can compete with it, and mine must become obsolete with the others. A still farther advance has been made by Mr. Macintosh by the discovery of a new explosive compound, which he states is perfectly manageable, and so reduced in bulk as that the full charge can be contained in the base of an ordinary Enfield bullet. I have now I believe given sufficient material for a discussion on the best form of Cartridge, and though I am aware that the subject is far from being exhausted, I think it is time to turn to the arms.

It would clearly be impossible in the limits of such a paper as this, to speak of every variety of Breech-loader, and therefore I have found myself compelled to arrange them in classes, in defining which, the two main divisions seem to be, the existence of a solid or hollow breech-block or chamber. Under the head of solid breech-blocks we find the Prussian; the Chassepot; the converted Enfield; the Needham;

the Albini Braendlin; the Peabody; the Berdan; and a host of others of greater or less merit, most of which would fire and extract the so-called Boxer cartridge much better than the "Snider." Under the head of hollow-chambered guns I find the Mont Storm, and the late modifications of it, which fire self-igniting cartridges; the North; the Lechmere; and some few others. While it is not my intention to go into the distinctive merits of each of these guns, there are certain principles which may fairly be the subject of remark. I have already adverted to the fact, that all the solid breech block guns which are made to fire a cylindrical cartridge, are of necessity coned out to the rear in the chamber or seat of the cartridge. It is also an evil of this form, that two inches or more of the gun is sacrificed, and that in every case some form of extractor is necessary. When to these necessary evils, are added such complications with spiral springs and sliding motions as exist in the converted Enfield, we are at a loss to conceive why the more simple forms of solid breech-block should be passed over, why work should be thrown on the hand which in other systems is better done without any separate motion, and what durability can be predicted for such generally clumsy contrivances. Very few indeed, out of the many forms of breech-loader proposed, would withstand an Indian dust-storm, or a Sydney "brickfielder." Sliding bolts and sliding surfaces generally, are especially liable to this objection, and also in common with spiral springs, are to be eschewed in all arms intended to be subjected to sea-air. Strength, simplicity, and cheapness are only to be attained by a right understanding and a faithful following of correct principles, and a sacrifice of these to expediency, will be sure to punish itself. There is another form of breech-loader still remaining to be noticed, namely, the magazine gun, which is full of ingenuity, springs, and levers. Those of this class that are only magazine guns, that is, fire a limited number of shots from a receptacle where they are stored, though very attractive to the uninitiated, are not capable of giving more rapid fire in the long run than an ordinary breech-loader which, like many of these, will fire 16 or 17 shots per minute. It is only where combined with a power of loading and firing single shots, that the magazine becomes of practical utility, and even here as the weight is constantly varying—and would be excessive in a full-sized infantry arm—the conditions are not favourable to accurate shooting. Add to this, that the dust storm would here be especially dangerous, and I think it will be evident that however applicable it may be for cavalry and artillery, the magazine gun does not yet take rank as a serviceable weapon for infantry.

I cannot conclude without drawing your attention to a most interesting early breech-loader from the Museum of this Institution, which arm in 1661 seems to have been made by an Italian genius. With all the difficulties of a flint lock and loose powder and ball, it accomplishes self-priming and fires it is said 20 shots per minute.

One of the guns using the Selwyn cartridge has been fired during the day by an attendant of the Institution and I will now show you how the cartridge draws itself after explosion. It has been kept,

since being fired, without opening, and as the effect is not easily understood, I have thought this the best mode of showing the action. I have only further to express my thanks for your patient attention, and to hope that the discussion will be conducted in the true spirit of scientific enquiry, with united good feeling in the pursuit of a common object.

Captain HORTON, R.N.: I should like to ask Captain Selwyn a question. Has it been ascertained throughout what distance of range the Macintosh projectile maintains its straightness of direction? You have kindly shown us an illustration of a short distance, but I should like to know how far the straight line of flight has been traced.

Major-General BOILEAU, F.R.S.: I had hoped to have heard some observations from professionals on the very interesting paper which has been read by Captain Selwyn, but presuming that they are gifted with more modesty than an old soldier is supposed to possess, I purpose to break the ground, and I hope the few observations I have to make—and they will necessarily be very few, for Captain Selwyn has really exhausted the subject—may lead to such further discussion of this interesting and most important question as will secure to the Government, as I believe it has already secured to it in another branch of arms—the artillery—a modification of the principles, which had been introduced to the prejudice, I think, of the interests of the Service, and to the introduction of other principles, which are now standing us in good stead. With respect to the calibre, I agree with what Captain Selwyn has said. I believe the half-inch calibre is the best that can be adopted. I have tried rifles of the several bores usually made use of, both among Volunteers and for long-range shooting, and I think the half-inch bore produces on the whole the most satisfactory results. The bullet may be made sufficiently light to be carried in greater numbers than the Enfield bullet, and sufficiently long to give good practice at ranges as great, probably, as will ever be adopted in practice in the field, namely, from 800 to 1,000 yards. It is not necessary, as Mr. Whitworth has proved at Woolwich, to have a small bore for accurate long-range shooting, for bullets of the Enfield bore have produced as satisfactory results at 1,000 yards as the small bore, a slight increase in weight only being given to them. There appears to me to be another advantage in not making the calibre too small. It is this, that if barrels are retained of the same exterior form, and rifles are retained of the same length as the long Enfield, the smaller the bore the heavier the rifle becomes. Therefore to make a rifle of small bore as portable and as handy as one of large bore, you require either to make the barrel thinner, which will make it weaker, or to make it shorter, which has also its disadvantages. These are reasons which may fairly be assumed for giving preference to the half-inch calibre which Captain Selwyn has adopted. Then, as regards the form of the breech apparatus, I have myself generally preferred the plug or piston system; that is, the system in which the plunger acts in collimation with the axis of the barrel, as having certain advantages over all other forms, especially in that freedom from obstruction in dust-storms and the adverse circumstances which affect others. Those objections are particularly applicable, I think, to the Snider rifle. And I must say, after having most carefully examined the several specimens of Captain Selwyn's rifles which have been exhibited this evening, and which we have had an opportunity of examining in detail in our Museum, I am almost, if not altogether, a convert to the principle which he proposes to introduce. I think there is this very great advantage in it, the entire absence of all springs and such appliances, which might in service make the piece absolutely useless. There is no disguising the fact that an opinion has got abroad, and I must suppose it to a certain extent to be founded on fact, that the Snider rifle, with the Boxer cartridge, is not a success. I will not say it is altogether a failure, but it has in so many instances been found that the cartridge case cannot be extracted, and that the rifles sent out for service have to be returned to the factories to have the cartridges extracted from them. I say if that be true, it is a fact sufficient to condemn the principle altogether. I never myself had any opinion of it, from the circumstance of its complication, and from the fact that unless the cartridge is pushed quite home, and both ends of the block-piece are

free, it is possible that the closing piece or breech block could not be so brought down that the rifle could be fired. An objection has been made to breech-loading apparatus on the principle which Captain Selwyn proposes to introduce, i.e., with a chamber of a certain dimension, namely, that you can only place a cartridge with a given charge of powder in it, and that, therefore, where a greater or less quantity of powder is required, the system would not be satisfactory. That may be very well for practice at long ranges at a target. But I think a rifle for use in the field ought to be so constructed as not to require two forms of cartridge under any circumstances. If we may assume, and I believe experience in the late wars has given us ground for assuming, that battles will be fought at *short* ranges and not at *long* ranges, then I say the objection to the cartridge being made capable of containing only one quantity of powder vanishes altogether. I may say also that the design of the breech apparatus appears to be simple, and not to have that objection which I referred to on a former occasion in this Institution in respect to the Mont-Storm rifle, namely, the heat of the breech causing the cartridge to explode prematurely. To hold the piece, as Captain Selwyn suggests, at the port, it may be loaded with the most perfect safety, while the copper case protects the cartridge from the heat of the barrel; the great objection which existed to the Mont Storm pattern of breech-loading rifle is thus obviated. I have made these few observations merely to break the ice in the discussion of this interesting subject, and to confess that I have been made a convert from a principle which, up to the present time, I believed, had been the best introduced, viz., the plug or piston system, to one which I have no hesitation in saying, as far as without experiment one is able to judge, the best form of breech-loader that has yet been brought before the public for the use of copper-case cartridges.

Captain G. V. FOSBEE, V.C., H.M. Bengal Army: I have only one objection to make to an observation made by the lecturer. It is the wholesale condemnation of every arm which contains a combination of spiral springs. I hear the same objection made to all arms made on that principle by the principal gunmakers of Birmingham and London. But I cannot help recollecting that 240,000 men went into a campaign last year, the mainspring of whose weapon was the spiral spring. The efficiency of every arm carried by every soldier of that army consisted in the spiral spring. Therefore I think the objection to any arm containing a spiral spring requires some little modification; the wholesale condemnation of them I cannot agree with. Further, when one speaks of the impossibility of men carrying two sorts of cartridges, it should be remembered that the whole system of musketry instruction divides men into two classes, the men who can shoot and the men who cannot shoot. The man who can shoot may carry a special cartridge, with a special charge of powder for a special weapon; and the second class man may carry either the double bullet cartridge, or some form of cartridge intended for short ranges.

Commander COLOMBE, R.N.: I should like to say one word as to the deterioration of spiral springs. I have an apparatus which is used on board ship. When first it was introduced I was obliged to use some spiral springs in it. I used thin steel watch springs; I found that these lost their vitality very quickly indeed. I then substituted brass spiral springs, which, I presume, the meeting will allow, are more likely to stand sea air than steel spiral springs. I still found that these springs deteriorated from the action of the sea air in a way that very much surprised me.

Captain SELWYN: Gentlemen will perhaps recollect that my observations only applied to the effects of sea air.

Mr. G. H. DAW: Having devoted many years to the subject of cartridges and breech-loaders, I have listened with great interest to the words from our lecturer, and I agree with him in many points. But before the Government decide upon the half-inch or small bore cartridge, they should well consider the matter; because if the cartridge used is one to be withdrawn, the case must be extended to such a length, that to a very considerable extent the part forming the breech will be weakened. There are many essentials necessary in a breech-loader; and unless a gun embraces all the advantages or wants of a military weapon, it will soon fall through from weakness, where it ought to have the most strength. I have tried all lengths and all forms of cartridge, and I certainly find that the present size of the Government cartridge is preferable for withdrawal cartridges. It carries the charge of

powder that has been almost universally adopted within the last few years; it gives a less length to withdraw; there is less liability to crack or stick than there would be in a longer one. The half-inch to carry the full service charge, whether the cartridge be metal or paper, has certainly many disadvantages. It has been found by those who have experimented in England, and also in France, at the present moment, that they are obliged to abandon many of their wishes with regard to the small bore, simply from the cause, that the cartridge, if it is withdrawn, is liable to split, or jam, or the rear end to be torn off. If we decide upon a change of cartridge, I have no doubt that the half-inch will be found to have many advantages. But speaking up to the present moment, I think the present gauge, taking the present bullet with the cartridge now in use, is preferable for many reasons, which I need not now detain you with.

Major-General BOILEAU: Will you permit me to make one observation with reference to what Mr. Daw has said? I respect him as a great authority upon the subject, but, perhaps it did not occur to him that in Captain Selwyn's form of breech piece, the same breech-piece suits any calibre. Therefore, a cartridge for a small bore is just as easily withdrawn as a cartridge for an Enfield bore. The breech-chamber and the cartridge are separate, and may be applied to rifles of any calibre. It is only by a contraction of the fore-part of the copper case, so as to make it fit bullets of different calibres, that the application to different rifles exists, all the other parts of the rifle are the same. Therefore with reference to any rifle which acts by a plunger, and in which the cartridge is first pushed into the barrel, and then extracted afterwards, the observations which Mr. Daw has made are perfectly correct, but I think they do not apply to that peculiar form of Captain Selwyn's breech-piece, which is applicable to any calibre whatever.

Mr. DAW: I think it would be preferable, even on Captain Selwyn's principle, with which I am well acquainted, to adopt the present size, because the breech-block would be shorter, and that part forming the breech would be considerably stronger. A military man may use his weapon in a very rough manner; and the larger the part to open for the cartridge, the more liable it is to be put out of order.

Mr. JOHN LATHAM (Messrs. Wilkinson and Sons): I would only make one observation which bears upon what Mr. Daw has mentioned. He speaks of "the usual service charge" which in this country is generally accepted to be from 70 to 75 grains. I have examined a great many of these new American arms which have been sent over, which are very ingenious, and very pretty in their action and mechanism. The only thing is, that they excite some misgiving as to whether they would work in action. But I find on careful consideration, that in the cartridges sent with them, the proprietors usually send charges of powder varying from 40 to 48 grains. When we consider that in England a service charge is considered to be 70 grains, and that in our proof, the gun which is to be fired with a 70-grain charge will have to stand a charge of 100 or 120 grains, I think we see why the Americans are able to be a great deal more ingenious and clever in their contrivances than we are. I think that the reason why there has been so little discussion upon Captain Selwyn's paper, is simply this, that Captain Selwyn has left so little to discuss. He has gone so clearly and plainly into the principles, that the majority of his hearers certainly must agree with him on every point. With reference to his own plan, it certainly possesses a merit which is very uncommon indeed in the plans of the present day—that is, *originality*. By making the powder serve as the extractor, he saves an additional piece of mechanism, and introduces us to an idea, which I trust has proved successful in his own modification of it, but which certainly is a new and very valuable one, because, as far as I am aware, it has not been applied in any other arm to a metallic cartridge. The conical form also which he adopts, he has very clearly explained to us. As we all know, it is theoretically the best form, and that which we lose in every other form of cartridge. We get in his conical cartridge the advantage of the patent breech, the improvement which was made by Henry Nock when he introduced the patent breech, and the advantage which was introduced in the Gomer mortar. I have now to point out as a very curious circumstance, that the plan of opening and closing the breech which has been adopted in the Snider rifle, is absolutely the very earliest to be found in England. In the Tower of London at

the present time there exists a breech-loading gun, a short gun, of the time of Henry VIII. (Captain TUPPER: A matchlock gun?). Mr. LATHAM: A matchlock gun, which has precisely the same method of opening and closing the breech, as the Snider gun, with a separate pan for the priming, which is fired by the matchlock in the ordinary way.

Mr. DAW: Will you allow me to say that if you look at the American cartridges which have been brought over, you will find that the ball is much lighter than that in ours, and that those cartridges vary in the charge simply for this reason, that some are for carbines, the others for muskets.

Captain SELWYN: I am extremely sorry to find that what I had regarded as merely raising points for discussion should have been accepted as anything more than what I intended it for. I am here, like everybody else, who is not a professed maker of artillery, as a learner; and I did think that this discussion might have been utilized as a means of telling us what neither the Government nor any individual can tell us. I can scarcely believe that any feeling of jealousy can apply in such a case, for it is merely the basis of the principle which each man carries out in his own way. And I did abstain from mentioning as much as possible anything that I had done in order not to encourage other people to think that it was necessary for them to defend their own views; but only that it is necessary for all of us to understand on what principles we are going to act. The question put by Captain Horton, through what distance the Macintosh projectile has been tried, can, I think, be answered by Mr. Macintosh himself, who is here present. I have not tried it through any distance myself, but he has tried it from a smooth-bore musket, and he will tell you the results as to range.

Mr. MACINTOSH: The reason for getting a superior range with my new projectile, with the same driving charge over the Enfield bullet, exists in its being a hollow tube. After the projectile leaves the gun, the wad from its lightness recedes before the column of air which passes through the cylinder; the air passing through, obviates in great measure the resistance in front of the projectile, and also the vacuum formed in the rear, which takes place in other bullets.

Captain SELWYN: Captain Horton's question was as to what range you obtained.

Mr. MACINTOSH: The range was 300 yards more than that of the Enfield bullet.

Captain SELWYN: With the same charge?

Mr. MACINTOSH: With the same charge.

The CHAIRMAN: What was the total distance?

Mr. MACINTOSH: I think it was 600 or 700 yards, I forget which.

Captain SELWYN: The same elevation?

Mr. MACINTOSH: The same elevation.

Captain HORTON: Another of my questions was whether it reached its destination without turning?

Mr. MACINTOSH: It did. The bullets which are represented on the board are smooth in the inside, and also on the outside. They are intended to be fired through a rifled barrel. You perceive that when the charge is exploded, the bullet expands and forces the metal into the grooves, consequently it is then dependent for its accuracy of flight upon the spin which the groove gives it. There is another advantage which I have found in using a bullet of that sort, that is, you can have a large exploding chamber in which your gas is thoroughly ignited. This causes the greatest amount of useful effect to be obtained from the quantity of powder discharged. With regard to the sabot that has been proposed, you use a small projectile and a large bore, and make up the difference of the diameter with the sabot. You have there a difficulty which in using my bullet is overcome. In using a smaller projectile it has been proposed to wind some light material round the exterior of the projectile, so as to fill up the bore; and it is supposed that in passing through the air that will come off. However, I think this would be very ineffectual. In this case you use a large projectile with the same useful effect, in consequence of the interior of the bullet being hollow. The advantage gained is, that you give a large amount of work or a high velocity to the projectile, with but comparatively little pressure of the powder gas, whilst lessening the atmospheric resistance. In reference to the means of ignition, the fulminate is put in a recess of the wooden plug, or wooden wad, the same as in any other central firing.

26 BREECH-LOADERS, WITH REFERENCE TO CALIBRE, ETC.

Captain SELWYN: General Boileau remarked, certainly more favourably than I expected, on the system which I advocate, when I am not employed as now, in reading a paper on the *general question*. He also remarked that there was an idea that a cartridge could not hold any charge that is required, that its charge could not be changed. Now in the so-called "Boxer" cartridge you will find cotton behind the bullet. People have said, "It is useless, this cotton." It is not so; it does contribute very considerably to the cleaning of the gun. And that cotton may occupy any space that is not occupied by powder; therefore, there is no difficulty in firing any charge from the same case. Captain Fosbery will be kind enough to remember that the whole of my words apply to the necessity for not using spiral springs at sea. Now, as naval rifles do see a great deal of service in the course of the year, in peace or war, we do think it is of the utmost importance that when they are specially intended for a salt-water atmosphere, and exposed to being washed with salt water occasionally, the springs should not, the first time we allow the hammer to descend upon them, give way, and necessitate Jack taking out the nipple before he can get in a new spring. I am afraid he has not patience enough to do that under fire; he is much more likely to throw the rifle at the head of the first comer. The army have chosen their artillery, the multi-groove breech-loading Armstrong; they have chosen their rifles. I do not think either of them will suit us at sea. With regard to two classes of ammunition being employed, there is not the slightest difficulty in doing that, if it is so desired. I have shown the form of cartridge which is adopted whenever a small bore is desired. The cartridge is then made in two parts, but the act of explosion connects them indissolubly together; so they are drawn as one, the joint of the copper coming just at the point of the annular ring, or the depressions, which I rather prefer. Captain Colomb's observations were, I think, confirmatory of my own experience with regard to spiral springs at sea. Mr. Daw spoke of the extension of length in the small-bore cartridge, which certainly is, as far as I have yet known, perfectly and accurately true of the cylindrical cartridge. But the same observation on this subject applies again to his views. When we speak of the Selwyn cartridge, no greater length either of breech-piece or cartridge is then necessary. Mr. Latham was also pleased to be extremely complimentary, for which I thank him most heartily; but I would rather hear from a man who has paid so much attention to the subject, some distinct expression with regard to the value of long range—something from which we can deduce the bore which we are to keep—something which may, indeed, advance not only my views on the subject, but those of every one who comes to this Institution. For I think the arms we see around us are a sufficient proof of the attention paid to the subject in the Institution; and that we are, if the members of any Institution are, fit depositaries of the principles of artillery and gunnery. These discussions have had, on very many subjects, most extended usefulness; and I have reason to know that they are viewed with very great respect by Governments abroad, and increasingly so by our own Government. Under these circumstances, I think I was not unwise in inviting the co-operation of the gun trade, whose interest is closely connected with the resolution of all these questions. I only hope that some one may read another paper on the same subject, which may be more successful in bringing out those views and those opinions on principles that will be of so great value to the whole country.

Major-General BOILEAU: I have to return my best thanks for the explanation which has been given of the method of charging cases with different quantities of powder. It is another instance of the advantage of cotton, and of the many and varied uses to which this material may be applied, one of which, in the case in point, adds force to the old saying, that cotton never can be worsted.

The CHAIRMAN: I am sure that you all wish me to return your thanks to Captain Selwyn, for the interesting paper he has given us. It has been suggested to me, to state for the information of those who may not be aware of it, that the rifles you see upon the table are from the collection in the Institution; and also that there are several others there which have not been brought down into the theatre. If there are any gentlemen present, inventors of new rifles, I should add that we shall be happy to receive any specimens they may be good enough to send us.

LECTURE.

Friday, February 1st, 1867.

COLONEL SIR T. TROUBRIDGE, Bart., C.B., D.A.G., in the Chair.

ON THE BEST MODE OF RECRUITING FOR THE ARMY.

By Captain NOAKE, Adjutant, Scottish Borderers Militia.

I AM so deeply sensible of the extreme importance and difficulty of the subject on which I am to have the honour of addressing you this afternoon—How to Recruit our Army being, I may almost say, the problem of the day—that I must at the outset bespeak your indulgence for any shortcomings on my part. Nothing could have induced me to come forward on the present occasion but the deep interest I have for many years taken in the soldier's welfare, and the hope I entertain that my humble suggestions may be criticised and sifted, to the advantage both of the Army and of the State.

When we take a comprehensive view of the present crisis, we cannot but look upon it as a warning sent in the time of peace, so that we may deliberate and wisely determine how to be better prepared in war, with an efficient Army in the field and with a reserve of trained soldiers irrespective of the Militia. As a help to this end, I shall first go into those influences which, in my opinion, bear injuriously upon recruiting: viz., inadequacy of pay and pensions, our Good Conduct code, the abolition of bounties, and the operation of the Limited Service (or Ten Years') Act. I will then submit that which I consider the best mode of recruiting. I shall, of course, have to refer frequently to the recommendations of the Recruiting Commission, shortly to be laid before Parliament.

First then, I shall speak of those influences which have undermined the present recruiting fabric, and will, I feel confident, unless removed, do still further harm.

Pay.

I was induced to collect much of the information contained in this Lecture from reading a statement made in debate on the Army Estimates of 1865, viz.: "that, through the fixed price paid for his rations, the soldier had now more pay by one penny a-day than he had formerly." This statement—a thoroughly erroneous one, except so far as applied to a short period after the Irish famine—was unfortunately allowed to pass unchallenged by the then Secretary of State for War, and so went forth to the world, only to leave a false impression on the public mind. I proceed to refute it:—nay, more, to prove that the soldier has even less pay than formerly.

Out of the Infantry soldier's pay of 1s. 1d. a-day, his compulsory payments for bread, meat, vegetables, coffee, sugar, keeping up his kit, washing, barrack damages, sheet washing, blacking, soap, &c., average about	9½d.
The following payments are not compulsory, but the little luxuries they provide are within the reach of every hale and hearty young labourer: viz., tobacco; and butter, or cheese, or a herring, for breakfast and supper	2½d.
There will thus remain to the soldier, for pocket-money or for beer	¾d.
Total	1s. 1d.

Were we to examine, at this moment, the ledgers of any Infantry regiment in the service, we should find scores of instances where for one month, and probably, in some cases, two, or even three months together, men have only received 1d. a-day; so that if that penny were spent in tobacco—and I have known a man to give away his dinner for tobacco—they could only have had dry bread for breakfast and supper all that time. There are hundreds of men in the Army who will only receive 1d. a-day all this present month.

And here I would mention—to show how statements are made at random—that an Officer writing on recruiting, in the December number of *Macmillan's Magazine*, asserts that the soldier has substantial rations, consisting of three meals a-day, and is left with a balance in his favour of about 4d. a-day; the fact being, that two of the three meals consist, as I have shown, of dry bread and coffee, while the third stands condemned by the Commissioners as insufficient; and the "balance," when scrutinized, turns out to be the imposing sum of three farthings!

The following calculations were made from the Army Estimates of 1844 and 1865, and other reliable sources, to show what really has been done for the soldier in the last twenty-one years, the period of a soldier's service.

It would not be convenient to go more deeply into figures just now.

In 1844 the soldier paid for his ration of bread and meat $3\frac{1}{4}d.$	} Now he pays $4\frac{1}{2}d.$, or $\pounds 1$ 16s. 9d. a year more.
Then he paid $\frac{1}{4}d.$ for his pound and half of potatoes.	
Then he paid $\frac{1}{2}d.$ each for his two oz. of butter for breakfast and supper.	
	} Now he pays $\frac{3}{4}d.$, or 15s. a year more.
	} Now he pays 1d. each, or $\pounds 1$ 10s. a year more.

After deducting from the total of these sums ($\pounds 4$ 1s. 9d.) his gain, through the reduced price of groceries, of 13s., we find his actual loss to be $\pounds 3$ 8s. 9d.

Multiply this by 79,000 (the number of men serving in the United Kingdom), and we find that the Army is paying more for the common necessities of life than it did twenty-one years ago by $\pounds 271,562$. Add to this the $\pounds 6$ a-year each to be deducted for the 15,000 men on the reduced pension, together with their loss through the difference in the value of money, and we find the Army a loser to the extent of $\pounds 361,562$ a-year.

Now how do the Commissioners propose making up this loss, in part, to the soldier? Not by a direct increase of pay, but by supplying him with articles in kind. This, at first sight, may appear quite an immaterial distinction; yet it is a point of vital importance, and the proposed plan would act, I think, most unjustly. It would still leave the Army, as a body, open to the taunting question of the civilian, "Who would work for 1s. a day?" It would be unjust to the country, as this 1s. a day does more harm to recruiting, than showers of circulars, distributed through magistrates and parish ministers, will ever remove. It would be unfair to the poor married soldier, as he cannot possibly afford to consume 1 lb. of meat in his family daily. It would be unjust to the economical, steady soldier, as it would deny him the privilege of putting money in the Savings' Bank, by being careful of his clothing. (And, having mentioned clothing, I would remind you that, though it is well known that many men wear out their clothing half as fast again as others, we still cling to the periodical issue of clothing. Many officers, I know, approve of it from the laudable desire to see their men look smart; but it must be in the experience of many to have witnessed a particular regiment in garrison, or troop or company in a regiment, where the men have been more discontented than those around them—the cause frequently being that all men alike are compulsorily supplied with an expensive article of clothing whether they require it or not).

I have proved that the soldier is paying more for his subsistence, by nearly $2\frac{1}{2}d.$ a day, than he did twenty-one years ago. Pay him back this, and his pay would be 1s. $3\frac{1}{4}d.$ a day; the shoes and half trousers given him gratis since 1844, together with jacket, half cap, and the additional $\frac{1}{4}$ lb. of meat recommended by the Commissioners, represent a money value of $2\frac{1}{2}d.$ a day more—in all 1s. 6d. a day. Out of this 1s. 6d. let the soldier be charged 6d. a day for his ration, and also for every article of his extra clothing, the same as for his necessities; this would encourage thoughtfulness and economy, and would be a

source of satisfaction and contentment. It would cost England no more, and would save her in appearance from driving so hard a bargain with her troops. For any sum less than 1s. 6d. a day it is hopeless to think of keeping our ranks complete.

Our Good-Conduct Code.

Our Good-Conduct Regulations, again, exercise a prejudicial influence on our recruiting. Those Regulations are, I think, in too many instances, open to the charge of being weak in conception, faulty in principle, and capricious in their working.

They are weak in conception, as they were designed to restrain the drunkard and absentee, the very men who would rejoice in extra pay could they get it; but who, practically, never try, and never hope to get it. Such men are kept in order by the power vested in the Commanding Officer, without any other aid whatever. The moderately good soldier, for whom the Regulations were not originally intended, and who did not require them, is the only one whom they benefit. They make the paymasters' accounts more intricate, give triple work in the orderly-room, and convert Captains and Commanding Officers into common clerks by obliging them personally to record the most trifling punishments.

They are faulty in principle. The man who aided in suppressing the Indian mutiny, perhaps fought seven or eight battles, wears the medal for distinguished conduct in the field, whom his captain knows to be a thoroughly good and brave though thoughtless soldier, sees his medal robbed of all its charm when, it may be, an incorrigible young scamp of three years' service is getting extra pay because he has just contrived to keep out of the regimental defaulters' book. A man may be thoroughly bad, yet get extra pay, and wear distinguishing marks for good conduct, nay, get extra pension, and a good character on discharge.

They are capricious in their working. Many men with three or four distinguishing marks for good conduct have returned from India, after suppressing the mutiny, to complete their service of two or three years, in the full hope of enjoying for life the benefits which these badges are said to convey, and which these same Regulations proclaim that every faithful soldier deserves. Yet from change of scene or circumstances, or from some other cause, they have committed themselves and lost their badges. They have thus paid in forfeited pension a fine of not less than £30 for each offence, their former nineteen or twenty years of exemplary conduct availing them nothing; and this in addition to undergoing the punishment necessary to enforce discipline. I have heard of men losing all four badges in the last year of their service, thus forfeiting £120. Will such men aid in the recruiting of our Army?

I would respectfully and earnestly ask the Officers of the Army, as a body, to consider the effect of protracted uncertainty upon the minds

and tempers of their men; the wrong inflicted upon the loyal heart, rough-hewn though that heart be; the effect of ignoring the noblest virtue that can animate a soldier's breast, true courage, by placing Routine in the front rank, chivalric dash and manly hardihood in the rear.

I witnessed the establishment of the Good Conduct Code, and for many years assisted in the orderly-room to carry out its provisions, and my opinion of it has never once changed.

I would here suggest—

That the soldier should have but one distinguishing mark: his medal for being in action.

That payment, as an indirect bribe to keep out of the defaulters' book, be at once abolished. Good behaviour is part of a soldier's duty; besides, the power vested in the Commanding Officer is sufficient to restrain the worst men in a regiment without the aid of such machinery.

That, instead, extra pay for length of service be granted: 1*d.* a day after seven, and 2*d.* after fourteen years' service.

That no man be deprived of his extra pay unless he be disgraced and passed to the second class.

That no man in the second class receive extra pay.

That time in the second class shall not count for extra pay, but previous service shall not be forfeited by being in the second class.

The advantages of this system would be that the soldier would be more contented while serving, knowing his extra pay to be a certainty.

Abolition of Bounties.

The advanced education of the day is, indirectly, another link in the drag-chain of our recruiting. The annual payment of wages in this country is over £300,000,000. It is now known, even by the fighting class, that the old household word "A veteran's shilling a day pension" is but a snare; and this knowledge keeps the thinking men from joining. The serjeant has not even bounty to offer. Yet bounty is but the earnest in the bargaining for life and limb, and a custom so old, so universal, and such a necessity in this profession of war, that I wonder how any one, even though regretting the system, could propose to abolish it. The Commissioners themselves, while opposed to the system, recommend bounties to induce men to re-engage in India. It may be argued that bounties are detrimental to discipline. Granted; but is not the tenderly-handled "Ten Years' Act," with its increased number of young soldiers and its striplings in stripes, still more so? Where 100 experienced non-commissioned officers left the Army in 1858, about 500 left in 1865. Will their successors, with much less experience, know so well *how* to command men; to study their varied tempers and dispositions; watch over, guide, restrain, and bear with follies and failings? Will they command the same respect, and be such stays to discipline?

The "Ten Years' Act."

The Limited Service (or Ten Years') Act is another, and perhaps the immediate, cause of our being so short-handed. For however thoughtless and reckless a man may be when he enlists, his spirit will inevitably be toned down by ten years of discipline; at the same time he will have learnt to set a higher value on his capabilities. Is he likely to re-engage for 1s. a-day, and only one-half the pension given to his comrade in 1854, when he can leave and share in the £300,000,000 paid for wages? No; so looking upon himself as an injured man, he turns his back upon the Service, resolved to persuade every young fellow in his neighbourhood to shun the Army, where, he says, there is not a fair wage for a fair day's work.

The injurious influence which these discontented men exercise on the recruiting can scarcely be estimated; and it is increasing daily, as they take their discharge. What else can we expect when England, not disdaining to take advantage of their thoughtless improvidence, their poverty, their ignorance, and the adventurous spirit which prompts them to break away from the dead level of a village life, dictates to them such terms as these:—"Our agreement shall be that you give me the best ten years of your life; that you be ready at all times, with your life in your hand, to do battle with my enemies, to guard my honour, and extend my trade; that all that time you shall follow no other occupation, or do anything to provide for a rainy day, to lay by anything for the time when your constitution is impaired, or the infirmities of age creep on you. In return for all this, I engage to feed and house you, but should you be cut off by battle, by shipwreck, or by disease, neither wife, nor child, nor mother shall have any claim upon me. Should you survive these dangers, I will keep you on the tenter-hooks of suspense, by not promising to take you on again. I may, or may not, give you at parting a good character; but in any case I shall send you back to your native village in regimentals, with 5s. in your pocket to provide food and lodging until you can get work: for clothes, you may find them as you can."

Now this is literally England's present agreement with the soldier; surely it is not to be the agreement of the future?

To remedy so great an anomaly, there must be a compromise: the country must make the advance. Can we call it an advance to add, as proposed, two years to the soldier's first period of service? To show the havoc made with the constitution, even with the present term: in the three years ending 1865, we had 42,457 recruits finally approved, while in the same period we lost by death, or invaliding, 24,971—more than 50 per cent.

I would suggest:—

1. *That the Ten Years' Act be repealed; and that in future all men be enlisted for twenty-one years; but—*

2. *That any man may claim his discharge at the end of fourteen years; it being at the same time imperative that he join an Army of Reserve, in*

which he shall serve fourteen years more ; then to be finally released with a pension of a shilling a day. It should be borne in mind that, owing to the difference in the value of money, 9d. a day twenty or thirty years ago was a better pension than 1s. is now.

3. *That soldiers who serve twenty-one years in the Active Army be finally discharged with 1s. a day pension.*

The soldier's pension is but a lottery at best, as there are five chances to one against his living and serving twenty-one years, so as to get even the minimum rate. Before he can obtain the maximum rate, he must comply with the condition of keeping out of the defaulters' book. How much better to name a sum, though a less one, which every recruit's mind could grasp, and every soldier look upon as a certainty.

To confirm my statement that there are five chances to one against the soldier living and serving so as to be entitled to length of service pension, I would state that out of all the men who enlisted in the years 1842, 1843, 1844, only 2,000 were discharged in 1863, 1864, and 1865 respectively, after having completed their full service of twenty-one years. It would be an instructive return that would show how many of these 2,000 men annually receive the maximum rate, and how many of the recipients were Officers' servants, working men, bandsmen, and others, who have greater liberty, and are not so closely looked after. My own conviction is, that nine-tenths of them are of that class, and only one-tenth of the hard-working duty soldiers. Surely there need not be so much cavilling about the rate of pension when so few get the pension at all.

4. *That men be allowed to purchase their discharge freely, at such a price as shall pay back their enlisting and other expenses ; and, if at home, to find a substitute.*

By this system the soldier would have the option, which he has not at present, of taking on again ; and the services of every man, in one shape or another, would be secured for twenty-one years. We should, moreover, save the expense of bringing men home for discharge.

While paying the soldier a very moderate pension for his fourteen years' service, we should ultimately get an Army of Reserve (which a fortnight's drill would at any time render efficient) without its costing one farthing ; for the men need not even be clothed, the only necessary parade being their quarterly muster to receive their pensions—the Staff for their payment is already in existence. Finally, our discharged men would be examples to the youth of their villages of what the country does for the soldier, instead of, as now, being a standing warning against enlistment.

Pardon a short digression. It has often struck me that the cause of recruiting is not assisted by the disparaging tone in which some military men who contribute to the Magazines allow themselves to speak of the soldier. I am free to confess that the result of the system introduced by Charles II. and his immediate successors, jealous of the constitutional forces, of depending for support on foreign mercenaries, and the impressment into the ranks of the refuse of our jails, was that the character of the soldier fell to zero. The desperate nature of these men, and the terrible discipline necessary to keep

them in order, caused every mother to look upon her son as lost when he enlisted.

All this, however, has long since been changed considerably for the better. Why not then appeal to the patriotism and encourage the pride that lurks beneath the pluck of our fighting class; why not rouse the martial spirit of our Army by dwelling on its matchless prowess, rather than speak of our soldiers as the off-scourings of our cities? Such language not only degrades the Army in the eyes of foreign nations; it lowers it in the opinion of the community, and thus damages the recruiting.

The favourite cry of our military Magazine writers is "a better class of men." Now who is it that is dissatisfied with the soldier? It cannot be the country, now upon her knees soliciting his services. Is it a Napier, who pays him such a noble tribute in his regrets?—"I should have won my promotion by being first in the breach, had not a man of my own company dashed in before me." Is it a M'Gregor or a Florence Nightingale, both of whom dwell in language so eloquent on his affection and devotion? In what particular, then, is the soldier deficient? The stamp of men we have is the only one we are ever likely to get, and well they fulfil the conditions of their hire. Gauge them as you will, measure them by any continental standard, and they are giants clothed with victory.

With the same gallant Officers to lead and guide, would the Indian strife have been more nobly sustained or sooner terminated; would the basis of Indian prosperity have been more permanently laid, or the sword have bound her to England with a stronger tie, had the 30,000 in the ranks who accomplished that mighty task been taken from the upper educated million instead of from the lower?

To my countrymen I would say: If you are not prepared to pay substitutes to fight for you, you must fight yourselves. Your not being able to get men to risk their lives for you for 1s. a day need cause no wonder. Why deny the soldier the right to participate with you in the general prosperity of the country? One-third of your surplus revenue would meet the difficulty. Try the very moderate sum of 1s. 6d. a day; if that sum does not answer, increase it. Only make the enlisting mart as attractive as that for labour, and men will flow into it like a river.

The Report, with all respect be it spoken, places the Commissioners in the position of a witness who tells the truth, but not the whole truth.

They tell us of the gain to the soldier through the reduced price of his groceries; but they do not tell us that his loss is five times greater through the dearth of his other provisions.

To combat the strong opinion in favour of retaining the "ten years' men" which pervades the minds of the Officers of the Army, they give a return to show that, while the casualties from all causes in the five years ending 1865 were 93 per thousand, only 14 were limited service men. But they do not say that the Act would not be in full force for eleven years after the commencement of the return (i.e., until 1870).

But what does this return really prove with regard to the working of the Act? Absolutely nothing: while it tends to create an impression unduly favourable to it. For, on reference to another return in the Appendix to the Report, we find that exactly one-half of the time-expired men took their discharge in India; *this* is the return to prove the working of the Act, and it confirms the opinions entertained by the officers of the Army. To show how gradually, yet how surely, the evil of the Act is progressing, in 1863 there were 1,927; in 1864, 3,592; and in 1865, 6,088 men who declined to re-engage. This, doubtless, will go on increasing until the climax is reached in 1870.

They tell us that there is a deficiency in the number of recruits; but they do not tell us that the deficiency is probably 18,000. This, I think, I shall make clear from returns which I hold in my hand. In the three years ending 1865 there were 42,497 recruits finally approved, while the casualties from all causes, in the same period, numbered 61,474, thus leaving a deficiency of 17,977. Should the same deficiency have occurred in 1866 as in 1865 (and doubtless it is even greater), we are wanting at this moment 26,000 men, and in the present year it will be 34,000. From this we have to take the late nominal reduction, provided there was no deficiency in 1862.

Nor is this the worst part of it. This 34,000 would be full 50,000 (or one-fourth of the whole Army) had we not, since the Indian mutiny, continued a war tax upon our manhood in taking men one inch, and for a short time, two inches lower in height than we have done in peace, for the last century, except when raising reserve or 2nd battalions. So that in case of war, we have not now the men between 5 ft. 5 in. and 5 ft. 6 in. to fall back upon. Nearly one-half of our recruits are now under 5 ft. 6 in., hence such a number of boys.

PROPOSED SYSTEM.

The best system of recruiting is that which shall procure the greatest number of men at the least cost per head. The foundation of the system must be, as at present, the giving and receiving the earnest or enlisting-money, and the completion of the agreement before a civil magistrate, in taking the oath of allegiance. I beg to call your attention particularly to this last point, that enlistment is not purely a military transaction—it is on a civil foundation that the superstructure must be built.

The Commissioners, after deploring the failure of the present system to develop the military resources of the country, go on to enumerate the advantages which a military career presents, and to recommend further privileges—scarcely one of which, however, can be appreciated by the recruit, and which, taken together, will probably fail to induce any more men to re-engage.

They then say that the high rate of wages is undoubtedly the obstacle to recruiting, to be removed only by higher pay; but, notwithstanding, they would seek a remedy in patching up the present organization. They would multiply almost indefinitely the number of commissioned Officers, back them up with non-commissioned

Officers and the Militia, and establish large dépôts for the reception of recruits.

The appointment of the additional Officers would be a useless expense, the rather that their regiments would receive no benefit from their services; the dépôts would be costly and almost useless, unless we had recruits in excess of the establishment.

As the Commissioners recommend having recourse to the assistance of the Militia, I shall here say a few words about that service in connection with recruiting.

For the information of the uninitiated, I may explain that for every man enlisted there is an allowance of 5s. to the subdivision Officer for clerking, postage, stationery, and other incidental expenses, and partly, perhaps, as a slight remuneration for extra duty.

As the Staff Officers of Pensioners and Adjutants of Militia act as Subdivision Officers, every recruit enlisted by their men reduces the allowance of some other Officer; for instance, I am myself an Adjutant of Militia, and were the recruits not enlisted by my serjeant, the recruiting party in the town would secure them, to the benefit of the district Adjutant. Some years ago the Militia did recruit, but long before the order was given to discontinue doing so, I had ceased to take any interest in the matter, from the want of that cordiality and support necessary to carry on my duties properly.

Nor do I think this will be wondered at when I relate the few following instances of the working of the present system, out of many that have come under my notice:—

Two of my own men enlisted for a regiment of the Line which had just completed its establishment; of this last fact I was not aware until I had reported their enlistment to the district and received for reply, "The men are not to be forwarded, as the corps is not open to recruiting." As the men's pay was running on, and I had no power to discharge them, I wrote for instructions, but was merely told there were no instructions to give. I was thus driven to commit the irregularity of writing direct to the Adjutant-General, who ordered the men to join their regiment.

Another man was rejected for being, as alleged, marked with the letter D, but having known him from a lad, I was convinced that he had never been in the Army, and on his return had him prosecuted before the civil court, where it was proved on oath that he was not marked and that he had never been in the service. I was obliged to take this step to recover the expenses.

Another man enlisted with the consent of the Commandant, but from the mistake of a clerk his printed "release" was wrongly dated; for this he was rejected at the district, although the writing of a letter would have set right the error, and although there is a general order saying that such an irregularity is of no importance provided the release is subsequently obtained. The Officer of Pensioners thinking the Inspecting Field Officer's decision final in such cases, never moved in the matter, and so lost the expenses, while the service lost a good soldier. This same Officer had a man rejected for being half an inch too tall; another man, on being rejected, went back home, was immediately picked up

by a guardsman, and is now serving. One man, enlisted by a pensioner, was rejected at one district for being marked for desertion, went to another district, and there was passed.

As such rejections almost invariably throw the expenses on the sub-division Officer, it need not surprise any one should he avoid running these risks by objecting to pass men whom he may all the time deem perfectly eligible, thus possibly obliging the recruit to tramp it to the head-quarters of the district before he can get enlisted, or causing his loss to the service altogether. A few days ago there were shown to me the orders from two districts to recruiting parties, and if I recollect right, they were worded thus :—"All regiments open for recruiting, except those detailed in the margin." How easy is it to imagine a serjeant stationed, for example, in Dumfries, recommending the recruit to go, we will say, to the 60th Regiment, which is stationed at Limerick, simply because he happens to have lain with the regiment, there being all the time a corps at Glasgow, to which the recruit would as readily have gone. It is within my own knowledge that of two men enlisted in Dumfries, not very long ago, one was sent north to Glasgow, round by Edinburgh, in order to get to Canterbury; the other sent south to Carlisle and Liverpool, in order to get to Glasgow.

Can we, in the face of such facts as these, refuse credence to the statement recently made in a military periodical, that each man obtained for the Army must cost, from first to last, nearly £20 before he is finally approved?

The system I am now about to submit in detail would, I venture to think, remove the antagonism between the services. It is this :—

1. That the recruiting be a separate department at either the War Office or the Horse Guards, and under the immediate supervision of an Officer of rank, as in the case of the Militia.

2. That all recruiting districts be abolished, as being expensive, unnecessary, and detrimental to the service.

[They are but relics of the ante-railway period, when recruits were collected in large numbers to be marched through the country by conducting serjeants, and when it took more time to communicate with the district than it would now take to communicate with the Inspector-General of Recruiting in London.]

3. That, instead of having recruiting districts, the Staff Officers of Pensioners and Adjutants of Militia be the recruiting Officers, corresponding direct with the Inspector-General.

[This would obviate the necessity of covering the whole country with Officers of the Line, taken from their regimental duties; while the fact of the Officers of Pensioners and Adjutants of Militia having served in, or now belonging to, the Army, and their sympathies being still with it, would ensure the duty being efficiently done. It would also release for other duties six Field Officers, Paymasters, Surgeons, and Adjutants. It would moreover save much useless expense, and simplify the service. One illustration of this : a few months

ago it was necessary to obtain a special authority to enlist a man at Dumfries. From the application having to go through the district, thirteen letters, including copies, had to be written. Had the application gone to the Inspector-General direct, the answer would probably have been received in two days, instead of a fortnight.]

4. That, as many men are lost to the service through living away in the country, all serjeants of Militia and all serjeant pensioners be allowed to enlist recruits; and that all other pensioners and all privates of Militia be allowed one-half of the enlisting money for bringing a recruit.

5. That, in London, where there are a number of parties, and duties for the paymaster irrespective of recruiting, there be a paymaster, surgeon, and adjutant as at present, to be under the immediate command of the Inspector-General.

6. That in our large cities and towns there be recruiting parties stationed as at present, at the discretion of the Inspector-General. These to be under the nearest recruiting officer, though he may be of a different service; a clause being inserted in the Mutiny Act to authorize it.

7. That any man be enlisted for his own country corps, if there be one, and he wishes it; if not, then for some corps near at hand, or as may be ordered from time to time, thus—Parties in Scotland to enlist for corps in Scotland; those in the inland portion of the north of England for corps at Preston; the midland counties for Weedon; those on the east coast for Chatham, as men can be sent even from Newcastle for 5s. each. The country would, of course, be divided into districts accordingly.

8. That all men be sent direct to their regiments.

[This would be an immense saving as compared with the present system, or the one proposed by the Commissioners.]

9. That all men be examined by a surgeon of the Line, if there be one, if not, the Militia surgeon to examine them before they leave their county; the examination in either case to be final.

10. That no recruit be rejected at his regiment, except by a medical board.

11. That should the head-quarters of a regiment of Militia be removed from its county, its place be supplied by parties from the Line at the discretion of the Inspector-General.

12. That the reward for enlisting be increased to £1.

13. That men be enlisted up to 30 years of age, except for the cavalry.

[This possibly may be objected to, as men of that age cannot generally be made so smart, and do not so readily take up their drill, as younger men. Still there are fourteen years' good service in a recruit of 30; constitutionally, too, he would be better able to battle with

the Indian climate. All men enlisting at that age might be transferred to the Army of Reserve at the end of fourteen years, at the discretion of their commanding officer. By this means we should have hundreds of additional recruits.]

14. That when a recruit offers himself through a bringer, it shall be lawful to enlist and attest him at once, if he wishes it ; in other cases, forty-eight hours only to be allowed. The present "four days" favours desertion, and causes unnecessary trouble to the serjeant.

Such, I submit, would be the best mode of recruiting for the Army.

I cannot conclude without expressing my regret that the limited time at my disposal has not enabled me to allude, except incidentally, to that branch of the service with which I am at present connected—the Royal Militia—a force of which, after some years' experience, I have the highest opinion, an organization on which I feel we may entirely rely, and which I believe to be almost indefinitely capable of development. The system I have ventured to propose would give us an Army of Reserve independent of the Militia ; but its services would, I think, be dearly purchased were it to be allowed to supersede, instead of supplementing, our old constitutional Army.

I would also say that if, in any of my remarks, I have let fall anything that may have sounded too strong—that may have been pitched in a key to which the ears of some of my audience are unaccustomed—I trust I may be pardoned. I have nothing extenuated ; but I can conscientiously say that I have set down nothing in malice. If there is one subject more than another which, for its proper handling, requires us to look facts—even unwelcome facts—boldly in the face, I conceive it to be the subject of this Lecture :—the great and urgent question "How shall we recruit our Army?"

Evening Meeting.

Monday, February 4th, 1867.

MAJOR-GENERAL THE HON. JAMES LINDSAY, in the Chair.

NAMES of MEMBERS who joined the Institution between January 21st and February 4th, 1867.

ANNUAL.

Commerell, John E., C.B., W.C. , Capt., R.N. 17.	Hughes, Waller Philip, Lieut. Coldstm. Guards.
Sharp, W. E., Lieut., R.A. 17.	Bruce, Harvey J. L., Lieut. Coldm. Gds.
Strange, Tom Bland, Capt., R.A. 17.	Wood, A. R. M., Lieut. Coldstm. Gds.
Boscawen, Hon. E. E. T., Lieut. Cold- stream Guards.	

A SHORT GUN, THROWING A HEAVY SHARP-EDGED DIS- COIDALLY-FORMED PROJECTILE.

By Lieutenant-General W. N. HUTCHINSON.

It is with much pleasure that I accede to the request of the Council to read a paper this evening respecting a gun which I patented in 1861. I will endeavour to be concise in my remarks; yet, as some visitors may be here who have not paid much attention to gunnery, I must, to make myself understood, risk the remark from those conversant with the matter, that I am at times repeating "a twice told tale," and explaining what requires no explanation; but it is due to myself to say I had the consideration to request that another subject, as well as the present, might be brought before you this evening. Yet the subject is one of importance, whether my project be right or wrong; for, notwithstanding the marvellous improvements effected within the last six years in our ordnance, and our being at this moment far ahead of every other country in effective artillery—unquestionably so at long ranges—it is certain that the nation is not fully satisfied—it does not feel confident that we have adopted the best method of rifling that can be devised. This is evinced by the changes frequently taking place, and by the fact that there are warm supporters of very different systems. The Americans have shown great inventive talent practically applied to useful purposes. We are indebted to them for useful lessons in ship-building, and for machinery in saving labour, both in domestic and agricultural pursuits. Ought we to feel positive that they are wrong in their avowed partialities for projectiles of vast weight? Not long ago they were much in

advance of us. They had a powerful serviceable gun for slow firing (the rifled Parrott), at a time when we had no gun of greater weight to oppose to it than the good old 68-pr.

They have recently evinced an unexampled capacity for war on a grand scale, and the ordnance we have seen on board the "Miantonomoh" prove that, regardless of expense, they act up to their professions, and unhesitatingly adopting the principles of gunnery advocated by their ablest artillerists, submit to the inconvenience in small turrets of guns of 20 tons and great recoil, discharging shot of 480 lbs. We read, too, of their having cast guns that will throw shot twice that weight. It is true we have heard of many of their guns bursting from firing heavy shot too rapidly—but this is no proof that heavy shot are not required, it is rather a proof that such guns are required as will project heavy shot. The "United Service Gazette" of the 12th ultimo tells us that the Americans were testing the endurance of a rifled 12-inch Rodman of 26 tons, by endeavouring to fire 1,000 rounds from it—shot 600 lbs. weight, powder 55 lbs. By the last report it had been fired 400 times, and continued as sound as ever.

The success of the Peruvians at Callao against the Spanish fleet was due, it is said, to a few 480-prs. We are told that Rhenish Prussia is sending to the Paris Exhibition a piece of ordnance of 17½ tons, that will discharge a cast steel cylindrical projectile of 1,100 lbs., using 60 lbs. of powder. Last summer an Italian iron-clad left for the Adriatic, carrying 600-prs. Indeed the defence from iron-plating so improves from day to day, that all scientific warlike nations are alive to the advantage, I might say necessity, of having heavy shot of some form or other that can be projected with good initial velocity, and maintain it longer than a sphere. How to obtain it is the question. The grand requisite at close quarters, which British sailors have always loved, is good initial velocity against iron-clads; yet no rifled guns have hitherto been constructed that will stand a charge of powder adequate to the double duty of forcing a ponderous projectile through the spiral grooving, and give it such velocity. Hence our artillerists have, as a rule, confined their attention to comparatively light projectiles, and have endeavoured to make up by velocity for deficiency in weight, and wonderful has been their success as regards terminal velocity and precision. We have seen it stated that vast sums have been *wasted* in attaining this perfection, yet no money can be better spent than in making judicious experiments to obtain the best arm for both our Navy and Army. It is to fight the guns that the expenses are incurred of ships, dockyards, sailors with their officers, &c., and those who have not thought upon the subject have little idea how small a percentage of the cost of the Navy is assignable to the guns, yet everything ultimately hinges upon their efficiency. It is ill-judged, false economy to be sparing of money for good arms. In 1859 I urged upon Government the advantage of providing our troops with breech-loaders, and a barrel that would discharge, when required, a hardened bullet to pierce a gabion or a mantlet. Contracts had just been entered into for large supplies of Enfields, therefore on economical grounds, if for no other, my proposition could not be entertained.

The country would have cried out, "What unnecessary expenditure!" and happily it has proved unnecessary; but it might have been fearfully otherwise.

It has been calculated that every effective bayonet on parade costs us fully £100 a-year. Bounties, pay, pensions, rations, clothing, barracks, hospitals, transport by sea and land, and other expenses,—cost of regimental officers, staff, commissariat, Horse Guards, War Office, *all* are solely incurred to bring bayonets into the field at the right moment; therefore it is reasonable to believe that every bayonet really costs £100 a-year, yet we begrudge a few extra pounds in the price of the barrel on which the bayonet is to be fixed. Verily John Bull is an inconsistent old gentleman! A barrel will last more than seven years; but say seven years. The difference between the price of the best self-priming breech-loader (obtained in large quantities) and an Enfield, would be less than £7; but say £7, which being an expense incurred for seven years, would be at the rate of an additional £1 a year. That is, the cost of a soldier superbly armed would be £101 a year; of a soldier indifferently armed £100 a year. In other words, 100 men armed indifferently would cost £10,000 a year; 99 men armed superbly, £1 less, viz., £9,999.* Comment on this fact must obviously be unnecessary, for there can be no doubt, other matters being alike, that the 100 men would have no chance whatever against the 99. If the country will only allow a certain fixed sum for the maintenance of its army, would it not be good policy to take 1 per cent. off its numerical strength rather than not make it as efficient as possible. But the calculations are on an extravagant scale. The extra expense of the better arm would be nearer ten shillings annually than a pound.

The admirable plan sanctioned for the conversion of the Enfield into a breech-loader, and the excellent ammunition devised for it, gives us good breathing time. Availing themselves of it, Government have advertised, offering a prize for the arm considered by an impartial committee the best suited to a soldier's requirements. Before long this step will doubtless put a first-rate weapon into his hands, for it is not so much the pecuniary value of the prize that will excite emulation among our leading firms, as the distinction of being the successful competitor, and manifestly they will find much opening for improvement. Rifled ordnance, however, has reached such perfection that it is difficult to imagine how it can be much further improved. But is rifling the best system that can be adopted for giving rotation to a heavy projectile; and is the cylindrical the best form for that projectile?

The three desiderata sought for in artillery are—

1st. Maximum weight of projectile.

2nd. Length and accuracy of range.

* 3rd. Facility in loading.

To attain the first, the size of guns has been increased, till their weight renders them almost unmanageable.

$$\begin{aligned} * 100 \text{ men} \times £100 &= £10,000 \\ 99 \text{ men} \times £101 &= £9,999. \end{aligned}$$

To attain the second, conical shot have been introduced, and barrels rifled to secure rotation. The conical shot, notwithstanding its inferior initial velocity, is a great improvement upon the spherical for light shot, yet it seems not the shape best adapted for traversing an elastic resisting medium; and when fired at an elevation, the resistance and displacement of air are increased by the axis of the shot soon deviating from the line of flight, the shot as it were travelling sideways. The longer the projectile the greater the evil, and when it *does* penetrate through the object aimed at, it makes but a small circular aperture. The rifling weakens the barrel at the same time that it increases the strain on it, and causes friction, and consequently wear. Nor has any altogether satisfactory method yet been discovered of reducing this wear by coating the projectile with soft metal. Much of the force of the expelling gas is spent in driving the projectile through the rifling that ought to be exerted in driving it forward and giving it good initial velocity. The greater the rotation (required for stability in flight), the greater must be the spirality of the rifling, and the greater therefore the *vis inertiae* to be overcome in giving such angular velocity to a longitudinally-lying bolt, often greater in diameter than the bore through which it is forced; occasioning in large guns a recoil that presents immense difficulties.

No country has as yet produced rifled guns that will with impunity bear sufficient powder to start heavy projectiles with great velocity, yet the friction is so severe, and the hot gas is retained so long in the bore, that although little powder is used, the barrel soon heats with rapid firing. Those who have had an opportunity of witnessing it say that the wear and tear is frightful.

The weight of a cylindrical shot is often increased by adding to its length, but in this case the gas acts upon no increased surface, the transverse area being the same whether the shot be long or short. To this is greatly attributable the peculiarly low initial velocity of long cylindrical projectiles. On the other hand, when the weight of the projectile is increased by giving it increased thickness (firing therefore from a larger bore), the flat surface at the rear causes a greatly increased vacuum during its flight.

The rotation round the longitudinal axis of all conical shot has this great disadvantage, that the instant the shot strikes any object not in a plane at right angles to the trajectory, the shot has a tendency to fly off rather than penetrate. It is owing to this rotation that effective ricochet firing along the line of a parapet has become impossible.

Elongated rifle projectiles, while sufficient rotation lasts, move throughout their flight in positions parallel to the direction in which they were first fired, hence they cannot strike the ground with their point foremost, except accidentally, after rotation has ceased, when they tumble over and become erratic in their movements. Such projectiles are consequently not suitable for vertical firing. Yet many naval as well as military men are of opinion that the more defensive-plating becomes a successful protection, the more will vertical firing be required.

These evils and deficiencies in large conical shot have much led to the

tendency we have lately seen to revert to spherical, and to build smooth-bores of cyclopæan dimensions. They give a good initial velocity, but it cannot be long maintained, owing to the large surface the sphere presents to the resistance of the air.

To attain the third desideratum, viz., "facility in loading," various systems of breech-loading have been invented, but every system hitherto introduced has caused such weakness, increased weight and expense, and been attended with such uncertainty, risk, and liability to injury, that *all* are fast getting out of fashion.

To sum up the inconvenience of modern rifled artillery guns, which peculiarly affect heavy ordnance:—

1. They have much recoil.
2. They cannot throw projectiles of really great weight.
3. They have little initial velocity.
4. They will not stand large charges of powder.
5. They cannot, when large, be readily loaded except at the breech.
6. They are not handy. They soon heat with rapid firing.
7. The propelling gas presses against but a small part of the long cylindrical projectile.
8. The heavier the projectile, unless made disproportionately long, the greater the vacuum in its rear.
9. They have, as a rule, little penetration when striking an object obliquely.
10. They make but a small aperture.
11. They will not, as a rule, enter; and none will cut a way through water.
12. They cannot be used effectively for enfilading ricochet firing.
13. They cannot be used for vertical firing.
14. They cannot, as a rule, throw red-hot shot, or shells carrying molten iron.
15. They are expensive.
16. They are not durable.

Doubtless immense talent and ingenuity have been exerted in manufacturing ordnance of a size, range, and precision that our forefathers would have regarded as fabulous, but is it certain that all this talent has been exerted in a right direction?

Mr. R. W. Woolcombe says (in a letter to the "United Service Gazette" of the 17th of last November), that as far back as 1854, he brought the subject of discs, and disc-guns to the notice of the Ordnance Select Committee.

In a valuable paper he read before the Royal Society in March, 1862, "On eccentric oblate bodies and discs as projectiles," he stated, that in 1859, with discs of nearly 8 ounces (virtually central sections of spheres) fired with 2 ounces of powder—the centre of gravity being placed above the geometrical centre—he obtained "a range" that, if not due to vertical deviation, must have been due to a velocity "of more than 2,000 feet per second."

At the following meeting of the British Association he read a paper on "oblate projectiles with cycloidal rotation, contrasted with cylindro-

"ogival projectiles having helical, or rifle rotation." He explained therein that with a four-sided gun, not eleven calibres long, made for his discs, powder about 3-5ths disc's weight, he had obtained, at an oak target, 25 yards off, with an initial velocity of 1,487 feet per second (measured by Navez's electro-ballistic apparatus), a penetration double that of a spherical shot fired with proportionate charges; and that the initial velocity of the disc, compared with that of the spherical shot, was nearly as 15 to 11. Copies of these papers which were printed, and the gun and discs, are in this house. He generally made his disc to rotate eccentrically by cutting out a small circular piece off both sides, near the zone. Surely it will be allowed that he deserves great credit for having been the first to point out how the eccentric rotation long known to exist in nearly 99 out of every 100 spherical shot, could be turned to a profitable account by substituting eccentric discs for spheres, and by that change obtaining less windage, consequently a greater initial velocity, and from the oblate form a far better sustained velocity:-

If half the genius and thought which have been expended since 1854 in the improvement of rifled guns, had been exerted in following up the very original idea first promulgated by Mr. Woolcombe, viz., that discs having eccentric rotation given to them would form better projectiles than cylindrical shot, it is probable that the country might have been saved millions of money, and now feel more satisfied that it possesses the best arm that could be used with powder or gun-cotton. I say, powder or gun-cotton, for mechanical and chemical sciences are making such vast strides, that he must be a bold man who will assert that years hence we may not have an entirely different description of offensive weapon.

The great penetrating power of Mr. Woolcombe's disc-gun seems to have been fully admitted,—but guns were already too heavy, and there was the drawback to its acknowledged advantages that the disc, being of much less weight than a sphere of some major diameter, was necessarily very light compared with the weight of the gun—and that the rotation was eccentric—a movement which, by displacing more air, was less calculated than when central to retain rapid rotation.

It appeared to me that these objections could be removed by firing the disc from the outside of a short chamber, which would allow of the disc being made of almost any weight, and of having central rotation. It would too, admit of its being cast in a yet better form for rapid flight, viz., with a sharp edge to cleave a path through the air, and leave but little vacuum in its rear. The sharp-edged disc is nowhere spoken of in Mr. Woolcombe's papers, but I have recently become aware that it is one of several modifications of discs described in his patent. A barrel of sufficient strength bored to that shape would obviously be so disproportionately heavy, that I had not previously imagined he had named such a form, and accidentally looking the other day at dates, I observed that in March, 1861, two months before the date of his patent, Messrs. Norris and Son (near Finsbury-circus) printed for me a pamphlet I drew up for private circulation, explaining with the

help of a wood engraving, how a heavy sharp-edged disc might be conveniently fired from the mouth of a shortened gun. This pamphlet which was read at the time by many, proves that the employment of such a shaped disc can be no infringement upon Mr. Woollcombe's patent, and it is certain that I am not interfering with it in other respects, for the principles of construction we propose widely differ. He fires his disc from within a barrel, I mine from without. He gives eccentric, I central rotation.

Though the gun I designed was singularly short I felt pretty confident a good direction could be given to the disc, but there was the undeniable objection to my project that the gas generated in so short a gun could act upon the disc for only a short time. I thought, however, that this disadvantage could be compensated for by making the gas press against a large surface of the disc—by giving the disc the most unrestrained freedom in quitting the gun—by having little recoil, yet a large charge ignited in several parts simultaneously, or by using gun-cotton. On the assumption that a light gun could in this manner be made to throw a heavy projectile with accuracy and with good initial as well as sustained velocity, I took out a patent for a gun, since renewed, which I believe on trial would be found—

1. To have little recoil.
2. To be capable of throwing projectiles of immense weight.
3. To have much initial as well as sustained velocity.
4. To stand large charges of powder.
5. To load, however large, with the ease of a breech-loader.
6. To be handy. Not to heat quickly with rapid firing.
7. To present a large surface for the gas to act on.
8. To have the vacuum in rear of projectile but little increased by adding to its weight.
9. To have good penetration, when striking obliquely.
10. To make a large aperture when it penetrates.
11. To throw a shot which will cut its way through water.
12. To be admirably adapted for enfilading ricochet firing.
13. To be particularly well suited for vertical firing.
14. To be capable of throwing red-hot shot, and shells carrying molten iron.
15. To be inexpensive.
16. To be durable.

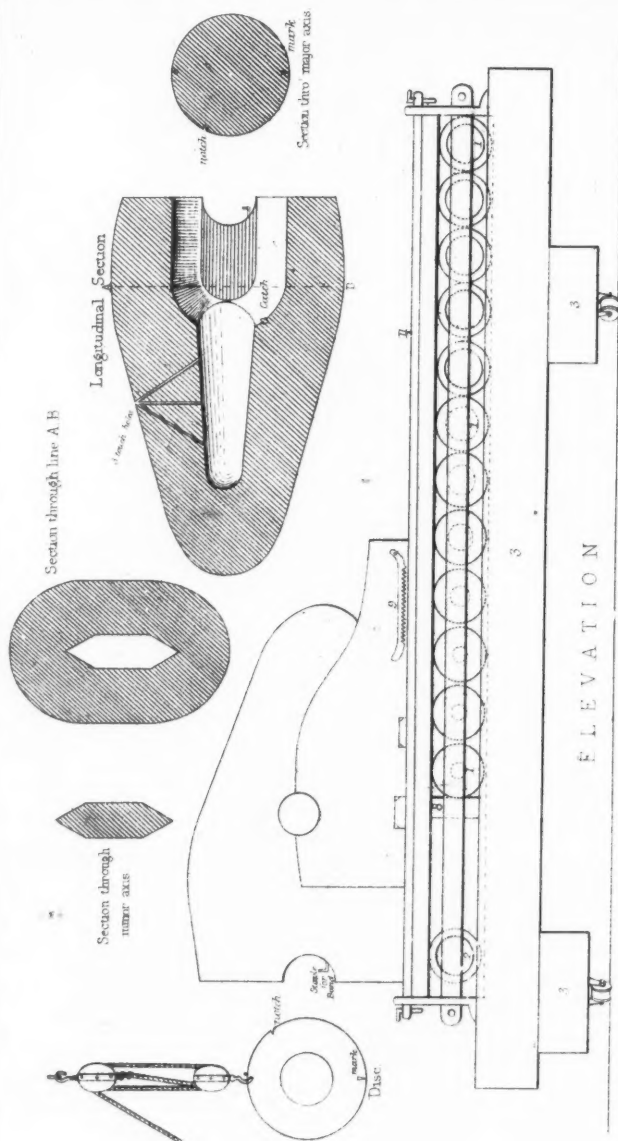
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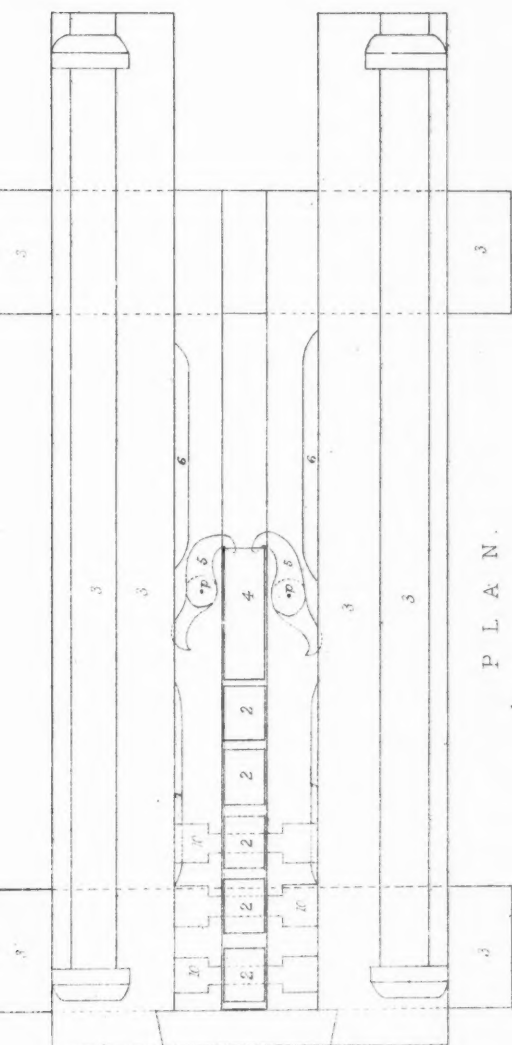
The projectile is formed of two equal frusta of equal and similar cones (cut perpendicular to the axis) united at their bases. In popular language, it may be called a sharp-edged disc. The following are the approximate proportions:—

Height of each cone about one-third diameter of base.

Height of each frustum about one-half the height of cone.

Less height to each cone would give a sharper entrance to the disc in its passage through the air; but this would inconveniently lengthen





P L A N.

- 1 Galvanized India Rubber rings or Sections of Cylinders.
- 2 Similar rings to receive the rebound.
- 3 Platform on which the carriage recals.
- 4 Block of wood lying in contact with rings.
- 5 Metal catch working on pivot & fixed to under part of carriage.
- 6 Two projections on each side forcing catch into position to grasp 4 on rebound.
- 7 Narrow projection lying in a place between projectors 6 forcing catch to free itself from 4 after the first shock of the rebound.
- 8 Iron projection from carriage to press on rings when gun recals.
- 9 Bolt hole to lock on projection 11.
- 10 Loose pieces of wood running through rings to keep them in position.

its major axis, thereby increasing the swell at the muzzle of the gun, and presenting an unnecessarily large surface for a side wind to act on.

Less height to each frustum would displace less air, but it would diminish desirable weight.

The major diameter is nearly thrice the length of the minor.

Nature seems to point out this as the best form that can be adopted. A schoolboy would gladly select a similarly shaped stone to hurl from his sling, or throw with a spin from his fore-finger, being almost intuitively sure that the spin would assist him greatly. We must all feel that a penny piece thus thrown would go much further than the same weight of copper cast in a spherical shape; and that the penny would fly through the air yet quicker were it filed at the circumference to a sharp edge. Surely in gunnery the best form for the projectile ought to be the first consideration; the next how to give it rotation without exacting much from the powder, or straining the gun; for without rotation there could be no stability, and therefore no precision or range.

When concussion rather than penetration is required, the sharp edge of the disc can be rounded off or flattened. The gun's form would thereby be the stronger, and the disc present less surface to a side wind; but Mr. Hodson, and more particularly Mr. Woolcombe, have shown the advantage of tapering large projectiles at the rear. This advantageous system of tapering is yet more fully carried out in the sharp-edged disc; and the great success that has attended Major Palliser's pointed shot is another argument in favour of the sharp edge given to the disc. It is chiefly from the Mitford bullet tapering towards the rear that its range is superior to the Enfield.

It has been calculated that a disc, an arc of 60° —the central section of a sphere—presents a somewhat smaller surface for a side wind to act on than does a cylindrical projectile of same weight $2\frac{1}{2}$ diameters long. The sharp-edged disc presents a much larger surface to a side wind; how much larger manifestly depends upon how much of the sharp edge is rounded off.

The gun is more the shape of a lengthened mortar than an ordinary gun (Plate II). It swells greatly towards the muzzle vertically in an oblong form, that it may receive the disc. The interior of the muzzle conforms exactly to the shape of the disc.

The exterior form given to the gun at the muzzle is supposed to be determined by calculating the thickness of metal necessary to resist the strain on the lines of greatest strain, viz., on the major and minor axis. That on the major axis is a bursting strain, such as the metal of a cylindrical gun is exposed to on every diameter. That on the minor axis is composed of a bursting strain, of much less severity, and a bending strain, so to speak, such as causes a bar loaded in the centre to bend, and would, by compression of the inner laminae and extension of the outer ones, tend to cause the flat sides of the bore to assume a curved shape. Through the extremes of the major and minor axis so obtained, an ellipse is drawn which describes the exterior form of the muzzle of the gun.

I have in the plan and model, made the muzzle extremely short. Probably it would be better somewhat longer, for the extremity might be so thin (especially as the gas expands there) as to add not inconveniently to the weight of the gun, and the additional length would allow the gas to act for a longer period on the disc. Many years ago Mr. Ross, of Exeter, built fanciful guns, the muzzle part being of wood, yet it is said they stood work for some time. This argues in favour of a light muzzle, and the gun would still be so short that there could be no vibration to affect the shot's flight.

The barrel may be cylindrical as in an ordinary gun, or conical, or oval, and not longer than suffices to hold the powder and wadding. Bored oblong vertically instead of cylindrically, more gas would press instantaneously on the disc, but the barrel would be weakened.

The barrel, if cylindrical, is exactly of the same diameter as the minor axis of the disc, therefore that axis determines the width of the bore. Should it be 9 inches, the disc would weigh about 800 lbs., the gun about 8 tons;* but this is only a rough approximation, much depending upon the quality of the metal used in forming the barrel, and whether common powder or gun-cotton be used.

In the experimental gun, a notch cut in the periphery of the disc, fitted on a small projection of steel fixed in the interior of the muzzle exactly where, when the axis of the gun lay horizontally, the vertical diameter of the disc came in contact with the gun. Much rapid central rotation was thus obtained without any friction whatever, but the projection ought to have been fixed further inwards. The disc at starting was driven with unnecessary force against the upper side, and consequently some power was wasted that might have been better employed in propulsion. Moreover, there was an unnecessary strain upon the projection, or "catch," as we may call it. This catch seems best formed by a bar of steel driven transversely through the enlarged muzzle. Clamps on the extremities of the bar on the exterior of the muzzle would aid in preventing the cheeks from expanding. There are several ways of giving central rotation to the disc, but the notch on catch seems the simplest and most effective.

As rapid ignition is required, several touch-holes, for the reception of friction-tubes, radiate from one central priming pan; or the charge might be fired in more places than one by a galvanic battery. Quick-burning powder ought to be used. Gun-cotton might be more suitable than common powder; and from the very interesting account of it given us in this theatre by Mr. Abel, it seems not improbable that it may some day be brought into general use.

Owing to accurate fitting, the inner sides of the muzzle and the top and bottom surfaces give a good direction. *All* depends upon workmanship. If the disc fits without the possibility of wobbling, it must always start in the same direction as regards the axis of the gun. The least bend near the muzzle of an Enfield, Armstrong, or Whitworth will always cause a corresponding divergence in the shot on its leaving

* A manageable gun could be made that would project a disc of far greater weight than 2,000 lbs.—W. N. H.

the barrel, and this divergence will invariably be a constant quantity. Under similar circumstances, it will be similar in every round. If the gun be well sighted, as far as can be judged from the trial made, there will be but little excuse for a bad score. The nearer the line of aim to the axis of the bore, the less is precision affected by any deviation of the axis of the trunnions from a horizontal position, therefore the sights, when it is practicable, will be placed on the side of the gun instead of above it. You will presently find that the Officer commanding the gunnery ship at Devonport has certified that he could not see why great accuracy should not be obtained as long as rotation could be preserved; and I think I shall be able to satisfy you that rotation will last as long as the disc travels. While it is rotating within the muzzle it should be in contact with the top and bottom and the two vertical sides, which all four govern the direction. The four sloping sides forming the two acute angles splay a little, about an inch from the extremity of the muzzle, in order that the disc, when escaping from the muzzle, may not touch those four sides. At one and the same instant the disc ought to cease being in contact with the muzzle in any part. This explains why a circular piece is cut off the muzzle. In this recess bolts are fixed for retaining the band (or stay) which will be described presently.

In order to prevent eccentricity laterally, which would cause lateral deviation in the flight of the disc, the mould in which it is cast should stand, as Mr. Woolcombe mentions, in a vertical position. One frustum—one-half of the disc should not be heavier than the other. The less distant is the centre of gravity from the central plane through the larger axes, the less is the divergence. Manifestly this distance will generally be less in the disc than in the sphere, as the major axis of the disc and diameter of the sphere being supposed equal, half the minor axis of the disc must be less than the radius of the sphere, therefore the divergence caused by unequal casting or the metal not being homogeneous, will, as a general rule, be less in the disc than in the sphere.

As it can rarely happen that the centre of gravity will be coincident with the geometrical centre, though it will usually lie in the same equatorial plane, the notch in the disc should be so cut that the centre of gravity shall be immediately above the geometrical centre. It was in this position only that Mr. Woolcombe felt certain of obtaining rotation with his eccentric discs, and evidently the rotation given by the notch locking on the catch ought always to be in harmony with the rotation that would be caused by eccentricity, were not central rotation caused by the catch. Whether, however, the rotation obtained by Mr. Woolcombe was similar to that of a progressing or a retrograding carriage wheel, he was not positive. The injury the experimental gun so soon sustained, prevented my easily ascertaining to a certainty which of the two rotations gave most initial and terminal velocity; for I had only to turn the gun over, thus bringing the lower part uppermost, to reverse the rotation.

In the specification of the patent for this gun, a description is given of a simply constructed machine for readily showing in what part of the disc the centre of gravity lies.

The distance from the catch (in the muzzle) to the extremity of the muzzle is set off on the periphery of the disc from the notch. A mark is made there. Large discs would be slung into position by a pulley hooked* through a hole nearly in the extremity of the diameter running from the mark. The hole is exactly so cut that in loading, when the tackle comes in contact with the upper part of the muzzle, this mark almost unavoidably meets the extremity of the muzzle before the disc is rolled into position by depressing the breech, the notch locking upon the catch, or the disc is slung in a nearly semicircular cradle, which could be readily attached to the stay-bolts, and by an easily-devised contrivance, tilt the disc into the muzzle.

When the gun is depressed the disc is held in position by a band or stay of some kind passing round its front. It is made weakest in the centre, that it may break in that part on the gun being fired. When much elevated, no band can be necessary. Should it be found, notwithstanding the adoption of more than one friction-tube, that all the gas is not evolved before the exit of the disc, the disc could (if deemed desirable) be retained in the barrel for any required time, for the band could be made of any computed strength.

Clearly all the gas would be evolved were gun-cotton used; and the able manner in which this important subject has been treated in this treatise has greatly interested us, and induced many of us to believe that the investigations of the present Government Committee will lead to the material being more generally adopted. The designed gun from the shortness of its barrel, and the easy escape of its shot is particularly well fitted to stand the shock of exploding undiluted gun-cotton. It has been calculated that to impart the same propelling power as common powder, less than one-third of its weight would be required in gun-cotton; and as instantaneous ignition is wanted, its bulk would not be much augmented by the intermixture of raw cotton as introduced by Messrs: Prentice, therefore the charge to produce results equal to the action of common powder would occupy, say half its space. It follows, that short as is the barrel (or chamber) represented in the plan, it would become much shorter were the barrel expressly intended to hold gun-cotton.†

Moreover, which is of vital importance, the space which the cotton should occupy would never be injuriously infringed upon. The carefully adjusted fibres of the explosive material would be as little liable to derangement as if lodged in the recess of a breech-loader, for the charge would be inserted by hand, and the upper and lower part of the entrance of the chamber would be slightly enlarged, to retain in position and prevent the further admission of a closely-fitting wad, made somewhat deeper than the cartridge.

I named certain advantages that, for heavy projectiles, I thought this disc-gun would on trial be found to possess.

* The hook with two steel clamps, which are as readily attached as quickly removed.—W. N. H.

† A wooden model of a gun-cotton 32-pr. has since been forwarded to the Institution.—W. N. H.

1. *To have little Recoil.*

Though the proportion that the weight of the gun bears to the weight of the disc is comparatively so small, there is but little recoil. Before the general adoption of breech-loaders, every sportsman practically knew that his double-barrel kicked, in other words, recoiled much when foul, from the rust or dirt retarding the passage of the shot; and that at long distances his birds were crippled, instead of being killed handsomely.

It is not rust or dirt, but rifling, that retards the cylindrical projectile and augments recoil. The sharp-edged disc stands on its edge in the *mouth* of the unrifled muzzle. Speaking theoretically, as the disc is in a vertical position, it is only in contact with the gun in *one* point, the bottom line of the muzzle becoming a tangent to the periphery of the disc all the time it is in the muzzle. A push from a child's hand would almost move a 2,000 lb. shot. Balanced on one point, it is ready unresistingly to roll through the muzzle, without causing strain or friction, the instant it receives a blow from the burnt powder, and thus offering little opposition, causes little recoil.

Action and reaction are doubtless alike, but the reaction on the moving power, from inert masses of similar weight put in motion by the said moving power, may be very different. No one will think that the reaction from starting an upright wheel is the same as the reaction from starting the same wheel when it is lying flat on the ground, or could be the same were its component parts in the form of a bolt lying longitudinally in the line of impulse.

As neither shot nor powder are retained long in the barrel, recoil is not a violent spring backwards, consequent on a projectile's sudden release from a state of severe restraint, but a more gradual, smoother motion, which in the experimental gun was effectively softened by being received on galvanized india-rubber sections of cylinders of same length, and same external diameter, but of gradually increasing interior diameter. This gradually decreasing strength made every section instantly take its own share of work. The resistance to recoil, slight at first, gradually increased. An arrangement was made for the force of the rebound being received in a similar manner by a simple self-acting mechanical contrivance, as shewn in the plans on the table. (See Plate II.) In a rolling sea, such a soft reception of the recoil and rebound might be found very desirable. Whatever may be the extent of the recoil, a many-toothed ratchet would retain the carriage, and thus husband the force of the rebound until released by the gunners to aid them in running out the gun when loaded. Clearly few men would be required to work the gun.

These sections of cylinders, designed as assistants to friction, might have been made of other elastic substance—of steel, or of a combination of cork with linen, after the ingenious plan once explained in this room by Mr. Clarkson. Whatever substance would best suit various

climates would be employed as the material for the sections. I have this evening spoken to Mr. Clarkson on the subject, who says that no temperature affects the elasticity of his compound material, which, in his opinion, would answer well for the sections. He took from his waistcoat pocket a rectangular piece not much thicker, and of not much larger area than a dollar, which had been subjected edgewise to a pressure of four tons, yet had instantly returned to its first form, retaining its original elasticity.

Friction alone (with inclination up hill) does not sufficiently resist recoil when much powder is burnt. Many of us have lately seen large guns topple over when fired with no very heavy charge. The lower a gun sits on its carriage the better, for its tendency to jump is diminished by the line of resistance to recoil being nearly in the same horizontal plane as the axis of the bore; and when the low-seated gun is doing duty in the bow or stern of a vessel, it is the less likely to capsize in a rolling sea. This disc-gun could be placed on any ordinary carriage and have its trunnions fixed very low, for it is so short that but little depression of the breech is required to give considerable elevation to the shot.

It has been observed that the projected gun is peculiarly adapted to gun-cotton, and were that substance employed, we know that recoil would be curiously diminished. I use the term curiously, advisedly, for there is much difficulty in satisfactorily explaining the cause of the diminution. With ordinary guns, experiments carefully made in Austria showed, effect produced being in both cases equal, that recoil was one-third less with gun-cotton than with common powder.

2. To be capable of throwing Projectiles of immense Weight.

As the sharp-edged disc is projected so easily, and the recoil is so little, the size and weight of the gun need only be limited by the quantity of powder that can be fired with safety to the barrel and embrasure (or port-hole).

Thanks to recent great improvements in manufacture, the very short barrel can be made capable of withstanding any reasonable bursting tension. Mr. Whitworth's new process of subjecting cast-steel while in a fluid state to hydraulic pressure, thereby giving it the properties and density of wrought steel, may add immensely to the strength of barrels. The bore of the proposed gun may therefore be of great size, and as its diameter is the measure of the minor axis of the disc, it follows that the disc may be of immense weight. Calculation shows that did the bore suit a spherical shot of 100 lbs., the weight of the proposed disc would be 674 lbs., that is, more than six and a half times as heavy, although fired from a lighter gun.

And with regard to the firing injuring the embrasures, does it not seem probable that this gun would be found, compared with other guns, to cause but little damage? The gas is not poured forth in the powerful concentrated stream in which it first issues from the barrel,

By being diffused over the large space within the muzzle before it quits the gun, its power to injure the embrasure is proportionately lessened.

3. *To have much Initial, as well as Sustained Velocity.*

We know that spherical shot have a much higher initial velocity than cylindrical. Hence the excellent performance of the 68-pounder within a range of 600 yards. I before mentioned that, conditions being as similar as circumstances would permit, Mr. Woolcombe found his circular-edged disc had far greater initial velocity than the sphere; and manifestly the sharp-edged, from its shape, would have more initial velocity than the flatter edged disc.

The experimental gun, imperfect as it was, with only six ounces of common powder, threw a sharp-edged disc eleven times the weight of the powder, a distance of 2,000 yards first graze. The chamber (or barrel) would hold no more. It would have been gradually deepened had not the muzzle cracked.

Considering the little powder used,—that it was ignited through only one touch-hole, and that the powder was not of a quick burning character, but the ordinary sort purchased from Government,—apparently great initial velocity was obtained. This velocity seemed principally attributable to the disc's not having to force out a column of condensed air packed in its front, to its sharp-cutting form, and to its being in a position to fly off with rapid rotation—a rotation which, being round the disc's shortest diameter, increased, it is thought, its velocity, from its climbing action on the air. When the trial was made there was so little recoil that had the amount of powder been, as is usual with many large guns, as great as a manageable recoil would permit, it is hard to say what range might not have been obtained.

The velocity of a sharp-edged disc is sustained for an unusually long period, because, from its wedge-like form and vertical rotation, it cuts a way through the air in the same manner that a vessel of fine-run cuts her way through the water; and also because, in the same manner that water presses inwards towards her stern and aids her progress, the air presses inwards on the sloping sides in rear of a sharp-edged disc and greatly diminishes the vacuum.

The area of a spherical shot taken through its diameter, and of the described disc taken through its minor axis being alike, it is computed that the vacuum will be less in the disc, from the shorter distance the air will have to travel to fill up the vacuum, than in the sphere in the proportion of about 5 to 8. Hence it is inferred that that particular cause of retardation will be mitigated in the disc to that extent—yet the disc will be more than twice the weight of the sphere.

Dr. Hutton says to the effect, that with a sphere no vacuum can be more complete than that caused by a velocity of 1,500 feet a second. It is then at its maximum—greater velocity would not increase it—but with the disc, retardation caused by a vacuum is not at a maximum until a velocity of 2,400 feet per second is obtained; yet,

from the inability of the rifle system to meet the requirements of heavy ordnance, some thinking men have recommended a return to spheres when under the necessity of projecting heavy shot. Surely discs would be better. Pray bear in mind not only the advantage of a fine over a bluff entrance into the air, but the fact that, weights being equal, the sharp-edged disc presents only about $\frac{1}{4}$ as great an area to the resistance of the air as does a spherical shot.

To attain long range all projectiles must be fired at a high angle. Many artillerists think that the long axis of elongated projectiles remains during their rotation parallel to the direction in which they were fired; consequently the greater from the point blank line is the angle at which they are fired, the greater is the resistance offered by the air; whereas the disc during its whole flight presents but one quantity, its transverse area, to be resisted by the atmosphere whether the distance traversed be long or short.

It has been argued that owing to the shortness of the gun, and the expansion of the gas the instant it leaves the muzzle, the disc cannot have good initial velocity. In reality, however, the large surface presented by the disc will have been acted on, in the direction of the first impulse, for some time after it leaves the muzzle before the gas can much expand. On a dark night this is well exemplified to the spectator who watches the firing of a gun or rifle. When too snow is on the ground, and there is no wind, it may be seen that the unburnt grains are not dispersed laterally, but lie in the direction of the line of fire.

We should see the cheeks of embrasures blown away whenever guns are trained much to one side, were there immediately much lateral expansion.

4. *To stand large charges of Powder.*

Diameters of bores being alike, the proposed gun, from its short barrel, must be more able to stand a bursting strain than a gun of the usual length, for the barrel is virtually no more than the chamber, from which the gas is instantly liberated by expanding into a space of more than twice the area, viz., the enlarged muzzle.

As before observed, it is the resistance of a projectile to expulsion, that by confining the gas strains a gun when much powder is burnt, but the sharp-edged disc by rolling out easily, and readily entering the air, at once liberates the gas.

Short as is the barrel, were gun-cotton employed, it would be still shorter, therefore much stronger, for the surface acted on by the bursting pressure would but little exceed the surface acted on by the propelling pressure.

5. *To load, however large, with the ease of a Breech-loader.*

The barrel is so short that the gun may be regarded almost as a breech-loader. This shortness of barrel gives great facilities for

quickly cleaning it, and ensures the gunners from all danger when sponging and loading rapidly. The arrangements for loading and working the gun are so simple that the most inexperienced hands could readily manage it. The charge of powder is inserted by hand. The disc is easily rolled home, and the alignment of the part not buried in the muzzle, instantly shows whether it is fully rolled home, and therefore locking on the catch.

In the excitement of action the worst that could happen would be the disc's expulsion without receiving rotation. There could never be a jamb. Under certain circumstances at close quarters, there might even be an advantage in the disc's being projected broadside on.

6. To be handy—not to heat quickly with rapid Firing.

From the gun being unusually light it is easily handled, and it is so short that it could stand conveniently in a turret. The muzzle would not project beyond it. Regard being duly paid that the cheeks be not injured by the gas, the port-hole would be a vertical aperture but little wider than the minor diameter of the disc, and but little higher than its major diameter, for in so short a gun, alterations in elevation would alter but little the position of the muzzle. A funnel could be contrived for carrying off the smoke. The ship whose guns can be served quickest, has an immense advantage at close quarters, and the disc leaving the muzzle the very instant the trigger lanyard is pulled, will, at all distances, be much valued by the Captain of the gun. From the gas soon escaping from the barrel and there being but little friction, the barrel would not suffer from heat in the most rapid firing. It has been stated that it is peculiarly suitable for gun-cotton, and as its ignition produces no smoke, it is to be wished that gun-cotton could always be burnt in whatever kind of gun may be used in turrets. From the result of experiments made in Austria, it may be inferred that the most energetic attempt to injuriously heat the proposed short barrel would utterly fail. In continued rapid firing with heavy ordnance, one disc gun would throw more shot than three rifled guns.

7. To present a large surface for the Gas to act on.

In ordinary rifled guns the gas expanding in the barrel acts but upon a small surface of the projectile. In the proposed gun it expands in the enlarged muzzle and acts directly towards the disc's expulsion on an area greater than twice that of the cylindrical barrel. The surface acted on is always proportionate to the weight of the disc. This, as before stated, is not the case with cylindrical shot. Were the disc fixed water-tight within the muzzle at a short distance from the barrel, and the interior of the gun subjected to an hydraulic bursting pressure, the pressure on the disc would be measured by the area of a section taken through its minor axis. In the same manner must the expelling pressure of the gas be estimated. This truism is ventured on, because the remark has been made, that the gas could not exert

its full expelling power on the disc, in consequence of meeting its sharp edge.

8. *To have the vacuum in rear of the Projectile, but little increased by adding to its weight.*

As the sloping sides of the sharp-edged disc remain at the same angle, however much the weight of the disc may be increased, additional size and weight, comparatively speaking, add but little to the vacuum.

9. *To have good Penetration when striking obliquely.*

The rapid rotation of a disc in a vertical plane seems to give it a tendency to adhere to, rather than glance off, any object it strikes. Therefore, as a turret can be increased in thickness to any extent, bearing as it does but a small proportion to the size of the ship carrying it, might it not be judicious, neglecting an almost invulnerable turret of a monitor, to attack her in her most vital part, viz., that part of the deck in contact with the turret, where any injury might create a jamb and prevent its revolving?

No projectile seems so likely to effect this injury as a vertically rotating disc. The resistance made by the gyroscope to any deviation from the plane in which it is rotating, shows that the disc if started vertically will strike vertically.

10. *To make a large Aperture when it penetrates.*

This aperture cannot be less than a section of the disc taken through its minor axis, an area obviously far greater than a transverse section through the minor axis of an elongated cylindrical projectile, weight of disc and projectile being alike. Caused by a heavy disc, it will be an unpleasant chasm between wind and water, to plug up in the heat of action!

11. *To throw a Shot which will cut its way through Water.*

A spherical shot, as long as it has any velocity, will ricochet time after time upon water. So will a round-headed cylindrical shot, but from rotating round its longest axis, it always glances off at an angle. This was painfully exemplified in 1864, at Plymouth. An Armstrong shot fired from the citadel, ricocheted at a considerable angle from wave to wave, all which unfortunately met it obliquely, until it finally struck a boat, and unhappily killed one of her men. Possibly some here present may remember that it led to my being tried at Exeter for manslaughter, and being placed, as a local paper triumphantly announced, in the "*felon's dock*." It was argued that being in Command of the District, I ought to have foreseen the danger, and forbidden all artillery practice in the Sound.

To enter water without ricocheting, cylindrical shot as Mr. Whitworth has shown must be flat-headed, a form directly opposed to progress. The rapidly vertically rotating sharp-edged disc, enters water and penetrates through it for some distance, without deviating from the plane in which it is rotating. With a rotation contrary to that of a progressing wheel, it would bury itself in water. By experiments made with a gun laid at low tide, and fired at high tide when it was completely covered with water, it was shown that double the ordinary bottom of a ship could be penetrated by a shot passing through 30 feet of water. As this was effected by a spherical shot, starting from a state of rest *in water*, it seems reasonable to think that a sharp edged disc entering the water with great velocity ought to have sufficient power to pierce a ship's bottom through more than 30 feet. A ship carrying such a gun might destroy her antagonist when rolling in a heavy sea, unless she was protected with thick plating to the very keel.

Were a small swift vessel furnished with but one light disc gun, to get near the largest iron-clad in a fog or a dark night, it is thought that the small vessel could destroy her large antagonist by firing no more than one water-tight time-fused shell with good aim below the armour plating.

But the adoption of the disc gun need not necessarily lead to the abandonment of ricochet firing at sea, which many sailors regard as most useful. Were the gun laid on one side, the disc would be projected horizontally, and would ricochet often, judging from its form. Most of us, when boys, have selected stones much the shape of the proposed disc to make "ducks and drakes" on the water, and when we have given them a good spin and thrown them horizontally, have been delighted with the length and number of ricochets we have succeeded in making on the surface of a smooth pond. Manifestly, however, the initial velocity of the disc fired horizontally, would be somewhat less than when fired vertically, for although the gas would not be forced to drive it through rifling, there would be the recumbent inert mass to set in motion.

Were the proposed disc cut longitudinally through its periphery, and one-half placed horizontally (flat side uppermost) in the muzzle of a gun cast for the purpose, it seems probable that an immense range could be obtained. Its rotation would keep it in a horizontal plane. The precision might not be good, but harbours and dockyards could be attacked from great distances.

12. *To be admirably adapted for enfilading Ricochet Firing.*

The rotation given to elongated projectiles being at right angles to the axis of projection, they necessarily, after every graze, make a considerable deflection in the direction of rotation, hence enfilading ricochet firing to sweep parapets, becomes very uncertain work with such projectiles; whereas the rotation given to the disc, coinciding with the axis of projection, the disc on striking the ground would not

diverge in the least, but ricochet for a long time in the direction of its first flight. This is well illustrated in the Japanese spinning-top, which, when it alights on one side, runs at a rapid rate along the ground. Rotation seems but little diminished in the longest flight. There are no buttons or projections on the disc from rifling to meet the air and thus gradually lessen rotation.

13. *To be peculiarly well suited for Vertical Firing.*

A mode of firing which many artillerists are of opinion must be more and more resorted to as defensive armour becomes more and more strengthened.

It was this plunging fire that recently destroyed the Danish cupola ship, and at Charleston the "Keokuck."

The proposed gun is obviously peculiarly fitted for vertical firing, as from the constant rotation of the disc in a vertical plane during its whole flight, some part of its edge must unavoidably impinge upon the deck, or building, or on whatever it falls. Gravity will bring down the disc, but as gravity would not act on rotation, it seems more than probable that when started with good rotation, rapid rotation would not cease until the disc struck. A penny piece thrown up into the air spinning will alight spinning. Against such a shot, if heavy, it would be difficult to make any buildings bomb-proof, and even should it alight on bare ground, as rotation, consequently progression, would continue, it might still inflict much mischief.

14. *To be capable of throwing Red-hot Shot, and Shells carrying Molten Iron.*

It is obvious that this formidable material cannot be kept for any time in a projectile coated with lead, or any soft substance that would melt. In the disc it could be conveniently carried, for its two flat sides are subjected to so little strain that they might be made very thin, thereby affording ample space for the molten iron, or for the insertion of Armstrong's beautiful shell arrangement. The cylindrical time-fuses and concussion-fuses would be increased in diameter as they decreased in depth. The segment-shaped pieces of iron would be in successive concentric layers, instead of being piled in successive layers, and the cylindrical cavity in the centre (containing the bursting-charge) would make up in width what it loses in length. The zone (if it may be so termed) of the shell would be cut into thin laminae parallel to the largest plane, and be slightly scored on their inner circumferences. These, screwed together (waterproof cement being interposed), would shiver into numerous pieces on the explosion of the shell. For security, each lamina might slightly overlap the edge of its contiguous smaller neighbour.

Many cylindrical shells are liable to explode towards the rear. The zone of a sharp-edged disc shell, made of Palliser's chilled iron, might

be cast so thick and strong that the chief explosion would always be in the most destructive direction, viz., laterally, for clearly that would be in the line of least resistance. The disc gun would act capitally as a mortar.

Few rifled guns can throw red-hot shot. They have occasionally burst even smooth-bores. This accident could never happen to the proposed gun—its shortness would prevent it.

15. *To be Inexpensive.*

There is no difficulty in constructing the gun, and the little metal employed, compared with the weight of the disc, shows that the gun will be inexpensive. Its durability, too, would, in the long run, make it singularly inexpensive.

16. *To be Durable.*

It *must* be durable, for, after it has stood the proof, there is nothing that can shake loose; there is nothing that can get out of order. When fired there can be no strain from the pressure of confined gas; it is free to instantly expand in the enlarged muzzle. The barrel or chamber is so short that metal need not be spared in strengthening it, with the object of making the gun light.

Used as a light field-gun, it might be made very effective against cavalry. Let the disc be formed of numerous thin laminae, cut parallel to the largest plane. On each side of the centre of the central lamina, attach a cone (made a little oblong) the height of half the minor axis of the disc, the diameter of the base of the cone twice its height. Corresponding holes being cut through the centre of the other laminae, the whole can be fitted together, and fired *horizontally* as one disc. The laminae will fly off the cone and spread like a pack of cards thrown with a twist from a conjuror's hand. Fired vertically, they would separate, and trundle along in slightly diverging directions.

To make the gun project into an embrasure, there is no reason why the muzzle should not be lengthened; but from its lightness and compactness, the gun, if furnished with Captain Moncrieff's most ingenious carriage, as described in number XLI. of the *Journal of the Royal United Service Institution*, seems peculiarly suitable for the upper decks of most ships not port-holed. In lieu, however, of the counterbalancing weight, which might be disadvantageous, I would suggest the practicability of substituting strong, upright, spiral springs, resisting extension at the front of the rounded elevator, and resisting compression at its rear.

The lower extremity of each spring would play in a fixed eye, in order that the other extremity might follow the arc described by the elevator. The useful action of these springs would be found precisely the same as that of the weight. "The force of the recoil" would be "gradually met by resistance, rapidly increasing as the gun" reached "its lowest position;" *vice versa* after the catch was released, and the gun raised into firing position.

This substitution of comparatively light springs for the heavy counterweight would, when the gun was in use, render it the less liable to roll over in stormy weather.

In case of injury to a spring, or in climates where the springs would be affected by intense cold, a box filled with spare shot might temporarily take the place of the springs. It is presumed that a few spare springs would always be kept in store.

When the sights are fixed on one side of the gun, a small, light shield might be attached at an angle to the carriage that would protect the gunner from the direct fire of musketry at the least.

The principle on which the disc-gun is constructed, admits of very extended application. The recoil is so trifling that it seems probable a formidable weapon, to be fired with a rest from the padded shoulder, could be made so light as to be conveniently borne by a mule carrying a good load of suitable ammunition; and that for a sportsman to kill "burra shikar," *large game*, a handy, yet most destructive disc-gun could be easily built.

What a cheap, convenient wall-piece might be constructed for destroying the thickest gabions and sap-rollers! Indeed, as the disc ricochets greatly, and never deviates from the line of aim, were not "fixing bayonets" a puzzler, I should be tempted to say that the ordinary weapon of the soldier might be constructed on this principle, and that he ought to be carefully instructed to fire extremely low when from smoke or other causes he cannot take a cool aim.

The light brass experimental gun I had made, was somewhat similar to the plan but with *much* less proportionate metal at the junction of the barrel with the enlarged muzzle. It threw a disc shot of above 4 lbs. Owing to the metal being too thin where I have described, the gun cracked at that part, the first trial-shot that was made from the gunnery-ship at Devonport. Possibly the metals forming the cast were not mixed in judicious proportion. The gun was then strengthened with a hoop over the crack, but insufficiently. Moreover, the bolt forming the catch got displaced, owing to its having been screwed in, parallel to the bottom of the muzzle instead of through it transversely. The trials, however, though necessarily very few, from the fracture increasing, appeared fully to establish that the disc rotated rapidly—that the direction was good—the recoil little—and, under the circumstances, the range most satisfactory.

The trial was witnessed by many Officers, who expressed great surprise that a gun so light compared with the weight of the shot should perform so well. The Officer commanding the Gunnery-ship, and the Officer commanding the Royal Artillery, were subsequently asked to give a certificate as to its merits.

I will read you what they wrote :—

(Copy.)

"H.M.S. 'Cambridge,' 12th December, 1864.

"I was present when Major-General Hutchinson's gun, throwing a "disc-shaped projectile, was fired from H.M.S. 'Cambridge.'

"Three shots were fired. Projectile weighed 4 lbs. 2 oz., powder 6 oz. The first shot at the 1,000 yards target was very satisfactory, the direction excellent. The rotation seemed to be perfect. The shot passed a short distance over the target.

"The two next shots were indifferent, which I attribute either to the projectile not being properly fitted to the gun, or else to the gun itself being injured.* So long as the rotatory motion can be preserved, I see no reason why great accuracy should not be obtained in striking an object.

"C. F. J. EWART,
Captain H.M.S. 'Cambridge.'"

(Copy.)

"Royal Artillery District Office, Devonport,
12th December, 1864.

"I was one of the spectators when the disc shot was fired from Bovesand in the direction of the Shag Stone Rock. The weight of the disc was 4 lbs. 2 oz., that of the powder 6 oz. The estimated range was about 2,000 yards, before it touched the water. There was no ricochet.

"A. A. SHUTTLEWORTH,
Colonel Commanding Royal Artillery,
Western District."

Addressed as you often are from this table by really scientific men, however satisfied I might be in my own mind that the proposed gun possessed the principal advantages of both rifle and smooth-bore systems, it might be presumptuous in me to appear before you this evening, were it not for these favourable testimonials.

Some of you may think that if I so fully believed the gun could prove useful, I ought as an old soldier, to have proffered it to Government. I considered such to be my duty, and I accordingly offered them the free use of the patent. I thought there was a chance of its being accepted, in consequence of the satisfactory certificates given by Officers whose opinions would carry weight, although I had no gun to submit for trial; yet I ought not to have expected that, with a proper regard for the public purse, Government would ever be advised to make experimental guns for inventors. Were an exception made in one instance, many would be offended.

I had never heard of Government manufacturing for any one; and having been President of the Small Arms Committee, I have been a good deal behind the scenes. The endeavour to satisfy those who forward for trial, arms and ammunition complete in every respect is hard work. In two years, while I was connected with the Small Arms Committee, we reported on, if my memory serves me right, 36 specimens of well-finished breech-loaders.

* It was subsequently found to have cracked.—W. N. H.

The number of inventions that would be submitted, *on paper*, with well drawn plans and descriptions, would be endless, and the resources of the present establishments quite insufficient, did Government undertake to manufacture specimens at the expense of the country.

At one moment I thought of building another trial gun myself, but circumstances needless to explain prevented me, and it was not until the arrival of the "Miantonomoh" that I again reflected on the necessity that seemed to exist for our being provided with ordnance able to discharge projectiles of really great weight with good initial velocity. I fear some of you may think I *ought* to have built another gun, and not have consented to appear before you until I could give more proofs of the capabilities of this kind of ordnance,—yet the certificates (corroborated as they might have been, had I wished it, by the testimony of many witnesses) that I have just read to you, from Officers in highly responsible positions, and whose characters are well known in the Service, prove that the project is not one of mere theory, but has stood the test of a fair though short trial. What a gun has done once, it will do again and again under similar circumstances, and you have unquestionable evidence that the trial gun, imperfect as it was, and radically wrong in the position of the catch, gave proof, though fired with only ordinary powder but $\frac{1}{10}$ th the weight of the disc, through but one touch-hole, gave proof, I say, of both accuracy and range; and I can state from my personal knowledge, that the latter was obtained when the gun, though repaired, was in very bad condition.

If violent concussion from a heavy sharp-edged, rounded, or flat-headed projectile (all the edge is one head) with rapid rotation—a rotation too that tends to prevent, instead of aiding its glancing off the object struck—be required to smash the armour-plating daily made of increasing thickness, it seems proved that the proposed gun, which is easily constructed, is well calculated to furnish such requisites to almost any amount, and at comparatively little expense. I am far from fancying that my proposition may not be improved on in its minor details, but I contend that it is on this general principle, ponderous shot ought to be projected. With heavy ordnance I contend—from saving of strain to barrel, and non-diversion of gas to procure rotation—that the simple plan I have suggested for obtaining rotation by a catch, is preferable to any system of rifling; and that for many purposes a sharp-edged disc is a better form of projectile than a sphere, or any modification of a cylinder.

²⁰ I subsequently devised a plan by which gun-barrels, and all cylinders subjected to great strain from within, might be strengthened to any extent, but as the gun, although the trouble of shrinking one cylinder over another was avoided, would be expensive in manufacture I will not enter further into the subject than to say that the plan is peculiarly applicable to hydraulic presses, and that the well known firm of Eastman, Amos, and Sons, after considering the principle of construction were so convinced of its correctness that they said they would try the plan, were they ever engaged in a large work, such as the Menai Bridge. Each of the series of cylinders forming the press is made to do as much useful duty as the innermost. This is effected by a calcu-

lated pressure increased successively from the outermost, upon each of the cylinders of fluid (so to call them) interposed between the metal cylinders. The pressure upon each cylinder of fluid (imparted by a small piston and spiral screw) acts as a support to the contiguous inner cylinder of metal, and is ultimately transmitted as a support to the innermost. The plans of a gun throwing a 1,000 lb. spherical, or a 3,000 lb. cylindrical shot, and of an hydraulic press, with the explanations and calculations, are in this room, but there is so little time I will not ask you to look at them.

It may be thought extraordinary by some who have not reflected on the subject, that I should advocate the introduction of guns I consider would prove so destructive—but there is humanity in efficiency. However paradoxical it may sound, all history shows, that the better the arm, the less the slaughter. The protracted warfare of the savage is one of extermination. Instead of having a thirty years war, the needle gun terminated a campaign in thirty days. Ships would not be recklessly brought into collision, did they carry such cannon, that a well directed shot from each, would probably sink both the combatants.

I thank you heartily, Mr. Chairman and Gentlemen, for having listened to me so patiently, and allowed me to take up so much of your time. The system I have suggested is such an innovation upon established theories and long usage, that I am not so unreasonable as to imagine it can at once meet with your approval, but I am sanguine enough to believe that the more you are pleased to think over the design—the more you reflect on the reasons that caused the badly proportioned, the only experimental gun ever tried, to perform so well,—the more you will be of opinion, that for many purposes the principle of construction I have endeavoured to explain, possesses important advantages.

The CHAIRMAN: After the very lucid statement we have heard from General Hutchinson of his invention, I hope that some gentlemen here present acquainted with gunnery will favour us with their observations upon the subject.

Vice-Admiral J. H. CODRINGTON, C.B.: One question I should like to put to General Hutchinson. Will he be good enough to explain how his gun would be placed on board ship? That is to say, considering it is very short, how it would be put in position to be efficient, and yet to project sufficiently so as to throw its shot clear of the thickness of the side of our present ships?

General HUTCHINSON: My idea was, that it was so thin a shot, going so much on its edge, that the embrasure or port-hole would be much narrower than for an ordinary gun.

Admiral CODRINGTON: I was speaking more of the actual length of the gun. The thickness of the ship's side would be almost as much as the length of the muzzle of the gun. Supposing the gun to be supported on trunnions, where would the carriage be? Inside the ship, or suspended in the port?

General HUTCHINSON: The carriage would not be much longer than any ordinary carriage. Besides the check there would be to the recoil from friction and from the inclination upwards, there would be the elasticity of the india-rubber sections of a cylinder. They would all check recoil. There would be very little. I remember Colonel Maberly, R.A., said he could not understand how there should be so little. He observed, "With a gun so light, and shot so heavy, how is it there is so little recoil? All the shot seem to roll out easily."

Captain STRANGE, R.A.: Without wishing to be at all censorious on General

Hutchinson's very excellent and lucid remarks, I am only surprised that they have not attracted more attention. But there is one point I should like to remark upon. It is, that the capacity as a shell for powder, of the disc form of projectile would not equal the capacity of the cylindro-conoidal. That to a great many minds is a drawback; because ricochet firing having been lost to artillery, as General Hutchinson has said, since the introduction of rifled ordnance, they have resorted to, and hope in future operations to depend more on the bursting charge of the shell. That small exception, I think, is almost the only point for the General to consider.

Lieut.-General HUTCHINSON: I thought that in the disc shaped shot the explosion would be altogether lateral; that there would be no fear of any discharge either in front or in rear. I thought that the sides of the shells might be made so thin that there would be ample space for the fulminating powder.

Captain STRANGE: It might be so; there would not, however, be the same amount of space. But that does not take away from its battering or ricocheting advantages. It may, perhaps, be less useful as a shrapnel shell. The spread would be lateral, and the balls of the shrapnel should have a forward action. I mention these two points, because if I can find so little to comment upon, not, I must repeat, in a spirit of censoriousness, I am only surprised that the plan has not attracted more attention.

Lieut.-General HUTCHINSON: It may seem presumption in me to address you at all upon this subject, not being a gunner; but I have thought a good deal on this subject all my life.

Captain SCOTT, R.N.: If you will allow me, I would say there is one point certainly that I, in common with many others, have listened to with a great deal of pleasure; and if it were more generally imitated, I think it would very much add to the results which the country would obtain: I mean the very generous way in which General Hutchinson has spoken of Mr. Woolcombe. I am sure we were all very much pleased with the way in which he spoke of Mr. Woolcombe, giving him most of the credit, speaking only of what he himself had done, putting Mr. Woolcombe in the fore front rather than himself. It has just been remarked, that what we want in a shell, is powder capacity. I must say myself, that one of the chief desiderata in connection with naval projectiles, is that of capacity; that unless we have a capacious shell we cannot afford to give up the ricochet of the round ball; we cannot afford to give up its many advantages without some compensation. At the present instant all the projectiles that are being made for battering purposes have little or no powder capacity. The present nine-inch chilled shell holds only 2 lb. 13 oz. The seven-inch gun has no battering shell. So that powder capacity, at present, has been in a great measure sacrificed. If General Hutchinson with his projectile, can get a fair capacity, and at the same time penetration, and the projectile does not fly off on striking at a moderate angle, he will have obtained a very great advantage indeed. But it seems to me that what the disc projectile is specially adapted for, is precisely what the General says, for vertical fire. Our vessels at the present time are all of them assailable by vertical fire. There is no protection against it. The decks are thin; a huge projectile falling on the deck would undoubtedly go through their bottoms. Then I think a still more valuable property will probably be that of firing under water. In the gun shaped as General Hutchinson has described, you have but to drop the shot in and fire. I believe that in future warfare we shall see guns fired continually under water. I believe that firing under water will be one of the most formidable means of attack as an addition to the torpedo. I think we must look to being assailed by the torpedo craft in all operations. We shall always have to be the attacking force, therefore our ships will be eminently liable to the operations of the torpedo. I believe that the effect of loading the upper sides of our vessels with armour, and leaving the parts under water unprotected, will be, that they will be speedily sent to the bottom. Although I do not quite agree in many points that General Hutchinson has stated, yet I do agree most fully in what he has said of the projectile rolling over, and the ease with which it is expelled from the gun. With our heavy guns of the present time, the interior of the gun gets heated, and is soon destroyed, to an extent, I believe, that very few are aware of. It becomes after a time like a ploughed field; and what General Hutchinson says of his gun not heating,

and not being destroyed, is undoubtedly true. In the first place, the disc-shot, in common with the round ball, which I confess I have still a weakness for, rolls over very easily, and will, therefore, be expelled from the gun very easily. Now, there will be a great advantage in that; that the gun will not recoil in the same violent way. Again, and this is a thing we have not tested with very heavy rifled guns, is the effect upon the gunner at the port. This gun will show a decided advantage in this respect. The only experiments I have witnessed of firing heavy guns together was in the "Minotaur," and, subsequently, in the "Bellerophon." In the "Minotaur," firing 150 lb. round balls from 12 ton guns, I found that I could stand at the port very comfortably; but with the rifled 12 ton gun fired from the "Bellerophon," it was very uncomfortable, indeed. When you come to fire a heavy elongated shot, the gas from the powder is raised to a very high temperature, and it expands on all sides. I believe the effect of it will be a very serious thing. There is another point that certainly is in favour of a disc or round shot, which is this. When we are in action, it is to be hoped we shall not play at long balls, but shall at once go in at the enemy, as we did of old;—because being the attacking force it has given us the victory, and it will always give us the victory; directly we come to act upon the defensive, we may give up the game at once—whilst we are the attacking force, we shall constantly find that the elongated shot, impinging against the water, will fly off at a tangent, and instead of striking the enemy, will very likely go on board a friend. What with studs coming out of the shot, and what with the tendency of the shot to fly off right and left, I believe we shall have plenty of accidents. Hardened or chilled shot, we know, constantly break up at the muzzle of the gun. Therefore, let us have something that is safe for ourselves to begin with. One does not like a gun that goes off at both ends, nor a shot that breaks up and strikes your friend as well as your enemy. Therefore, I say, let us have the round ball or disc. I think I have shown some points in which the disc is really valuable, and I am sure that General Hutchinson deserves every credit for his success. We may find the disc shot turn out to be more valuable than was thought possible before we heard his explanations.

Commander W. Dawson, R.N.: Some six or seven years ago I had some experience in experimental firing on board the "Cambridge" with disc shot, similar to that of General Hutchinson's. Certainly, the range we obtained from it was very considerable considering the means we employed. The disc employed was that of Mr. Woolcombe. Speaking entirely from memory, and merely to give you an idea of the general dimensions, I may say that the shot was about 1 lb. in weight; the charge of powder was two or three ounces, and the gun was a very small gun, which was fired from a height of about twelve feet from the water's edge. I think we fired it at an elevation of one degree. It gave a range of about 700 yards. I had an idea that this disc shot, although it might give a very good range, could not possibly give a good direction unless the disc was perfectly vertical. In order to test these points, Mr. Woolcombe, who loaded the gun himself, gave the carriage of this gun a heel of about four or five degrees; he laid the gun again at the same mark, and it went four, or five, or six hundred yards to the right of the mark. The number of shot Mr. Woolcombe had was not great; but we repeated that experiment, and the shot went again in the same extraordinary direction. It exactly confirmed the theory in my own mind, that the plane of the trajectory of the shot must be exactly vertical, and that in order to get accuracy out of the disc-shot, you must quadrature your gun and lay it with a spirit-level across the trunnions. That is a very serious difficulty, which probably can be overcome for experimental purposes on land; but it is perfectly impossible to overcome that difficulty on ship-board, even in the smoothest water. The decks of a ship are not like the flat plane of a battery on shore; and when the gun is extreme trained, even in smooth water, it is thrown out of its quadrature one or two degrees, as the case may be, and depending upon the inclination of the deck. So that it is impossible even in smooth water, and of course, when the ship is heeling a little by the action of the wind, it is still more impossible to get over that difficulty. So I am afraid my experience with reference to accuracy differs somewhat from Captain Ewart's more recent experience. I speak only from memory. I think I understood from Mr. Woolcombe the way in

which he got at this disc-shot. It struck me as rather peculiar. It was rather the result of accident than of calculation. He said he was looking for the proper and best form of projectile, and he thought he would find it in some bodies of nature. He thought, perhaps, if he studied the planets he would find among them a planetary body which presented the best shape for projectiles, and he thought the planet Jupiter would do. But he found it was rather difficult when he reduced the planet Jupiter, to get it into a gun. He then shortened the minor axis; he found still that the shot had a tendency to turn upon one side, and to jamb. He then took a sphere, and he cut a slice off one pole, and a slice off the other pole; and thus we get the form of the disc-shot which we have before us, without the sharp edge, but with a curved edge. That was the particular disc to which he confined his experiments. He got rotation, not by the "catch" plan which General Hutchinson has now introduced, but by altering the centre of gravity of the shot, by boring a small hole on one side. And his gun was not similar to General Hutchinson's gun; but it was the ordinary long gun, with the bore shaped to receive the disc. The way he got the gun made, on this occasion, was by simply filling up a cylindrical bore with two cheek pieces, one on each side. That was only a temporary arrangement for that particular gun. The other points brought forward by General Hutchinson are quite different from what Mr. Woolcombe then brought forward, especially the short gun which General Hutchinson has introduced. I do not think that the General quite understands Admiral Codrington's objection. It appears to me that Admiral Codrington wishes to get the muzzle of the gun outside the ship before firing it. That was the objection which I think was not exactly understood; and it is a serious objection for ship purposes.*

Lieutenant-General HUTCHINSON: It would not apply to a turret.

Commander DAWSON: Still the muzzle must always be external to the ship. I dare say the difficulty is to be overcome; you can make your gun longer. I do not see why you should restrict yourself to a short gun.

Lieut.-General HUTCHINSON: There was only one gun that was ever tried. Unfortunately it was too light where the enlarged muzzle was joined to the short barrel. Captain Ewart knows the excellent shot he made with it. It went over the thousand yards' target. I had it hooped up afterwards, but we are always liable to meet with accidents with first guns.

The CHAIRMAN: The thanks of this Meeting are due to General Hutchinson for having brought forward this project. I think you will agree with me, now that he has laid this system before the meeting, that it will have the effect of turning the attention of the Authorities to it, in order that it may receive those trials which he himself ardently courts.

* General Hutchinson, finding that he had omitted to notice Captain Dawson's argument, is anxious to state that it appears difficult to think how the deviation can be attributable to the cause suggested, as the action of the air on any side of the cylindrically rotating disc will not be altered, whatever may be the plane in which the disc rotates. There seems no reason, apart from gravity, why the shot should deviate more from the prolonged axis of the bore of the gun in one instance than in the other. He also desires, further to state in answer to Admiral Codrington's query that the gun would be inside the port, the muzzle might be much lengthened, yet be light, for the bursting force of the gas is diminished by being spread over a space of greater area than the barrel, and as the unopposed shot would be flying out with great velocity, the gas, without straining the sides of the gun, would relieve itself by following the flying shot.—ED.

"ON THE WORKING OF HEAVY BROADSIDE GUNS."

By ANDREW A. W. DREW, M.A.

It is exactly two years ago, within a day, since I had the honour of reading a paper in this Institution, entitled "A few rough ideas for the Construction and Arming of Iron-clad Ships of War."

Since that time very great progress has been made in the art of manufacturing armour plates and chilled iron shot, but from all I have seen and read, very little has been done, either in the improvement of naval guns, or in the method of working them upon the broadside. Two years ago, the 12-ton Armstrong gun was the most effective weapon possessed by any English ship of war, and I believe I am not wrong when I say it still holds its position.

Those of you who were present in this room on the 5th of February, 1865, will remember that I proposed a method of working these 12-ton guns upon the broadside, which method, if it were adopted, would secure many advantages not possible in any existing plans, and would remove many disadvantages which mar their effect.

On that occasion I did but touch lightly on the plan for working the guns, the description of which plan occupies only two pages in the 9th volume of the Journal of the Institution, though, as may be seen by reference to my paper read that evening, that the scheme was then complete, as I shall present it to you this evening, with the exception of a plan which I have recently devised for running heavy broadside guns in and out, and this sees the light for the first time this evening.

Within the last few months I have had the opportunity of inspecting the three different methods of working 12-ton guns on the broadside, which have been adopted for competition in the "Bellerophon;" but, in my estimation, they are all open to the following serious objections.

1. They cannot give sufficient command over the guns, in a heavy sea-way, to insure their being worked with efficiency and safety.

2. They do not provide for any increase of lateral training, beyond that possessed by all broadside ships, viz., about 30° each way.

3. They do not afford so great an amount of protection for the gunners as the ordinary methods, inasmuch as the ports are larger.

4. The system of pivoting is weak, in two out of three of the plans, and exceedingly liable to become deranged in action. The plan adopted by Captain Scott is, no doubt, a good substitute for a pivot, but I do not think that it will be found possible to work 12-ton guns in a heavy sea, without the use of a *bona fide pivot*, much stronger than those in use, and perfectly protected from the chance of injury, and therefore to be depended upon under all circumstances.

I am fully aware that it is quite impossible to secure every good point for any one plan of training and working heavy guns, and that the question of superiority is only one of degree.

The existing plans are good, until we find better. The question, therefore, is "what good points do we most require for the working of heavy broadside guns?"

I have already stated the principal objections which I make against the three competitive plans for working 12-ton guns, as fitted in the "Bellerophon;" and I think I can show that their defective points are, of all others, those to which the greatest amount of attention should have been paid.

I claim that my plan does not possess any of these objections, and that its drawbacks are not nearly so serious as those of the experimental plans; while its advantages are very much greater.

I ought perhaps to state here that soon after my appearance in this theatre (on the 6th February, 1865) I submitted my method of training heavy broadside guns to the late Admiralty, telling their Lordships that my plans were quite at their service, without fee or reward, should they desire to make any use of them. To my great surprise I was immediately requested to call at the Admiralty and explain my plans in detail. I had expected that, perhaps in a couple of months' time, I might receive some intimation of their Lordships' pleasure, but in three days from the time I despatched my offer they were in full possession of all I had to tell them. I was received at the Admiralty by the Comptroller and the Chief Constructor of the Navy, both of whom went carefully through the plans, point after point; and, at the conclusion of a long interview, the former gentleman informed me that the Chief Constructor and himself had formed so good an opinion of the plans proposed by me, that it was their intention to submit them to the "board," for adoption, or at least for competition with other plans. This accordingly they did; but, alas! some member of the board thought he saw a defect, and imagined that the port I proposed would weaken the side of the ship to an undesirable extent, though the Chief Constructor had allowed in my presence that this need not be the case. Indeed on actual measurement I found that my port did not require so much of the ship's side to be cut away as the present style of broadside port. Nevertheless, I was informed that the (supposed) objection was fatal to the adoption of my plans.

Upon receipt of this letter, I made an application to be informed as to the precise *grounds* upon which the objection had been based, as I had reason to believe that I could easily overcome it, and that further suggestions from me would be found to meet the objection.

Their Lordships thereupon commanded me to be informed that "they could not take upon themselves to disclose the grounds upon which their decisions were based, but would be happy to receive any further suggestions from me."

Considering that I was not a professional inventor, seeking reward at their hands, I thought that their Lordships might at least have allowed me to know the precise nature of the objections they had discovered, in order that if they really existed, I might know in which direction to turn my attention. Not unnaturally, I declined taking any further trouble, determining that if I ever pursued the matter, I would await

some fitting opportunity for coming here again, and inviting discussion among the scientific members of this Institution, upon the merits and demerits of my system of working heavy broadside guns.

I will now describe the general plan which I sketched out in my former lecture; first observing that the points I aim at securing are, perfect control over the gun, under all possible conditions; a large amount of lateral training; a small open port; a simple but powerful mechanical contrivance for training the gun which shall enable *one man* to keep the gun bearing upon its object; a similar contrivance for running the gun in and out, also to be effected by *one man*, in a very small space of time; and lastly, an adequate amount of protection for the crew of the gun and its necessary machinery.

These, it will be allowed, are all great advantages. I proceed to secure them by the following means:—

I first of all pierce the ship's side, and form what appears to be an unusually large port 4 feet wide and 6 feet high, the upper portion of which is circular, and the edges of which are square, *i.e.*, the port is cut straight through the ship's side, at right angles to it, without any beveling away inboard. I have been told that such a port would weaken the side of a ship to an undesirable extent, and, as far as I have been able to gather, this was the real reason why the late Admiralty did not adopt my plans.

The Chief Constructor had pointed out to me that this might be urged as an objection; but upon my asking him "whether he himself believed my port weakened the side of the ship to a greater extent than *those ports already fitted to certain broadside ships for 12-ton guns*;" he candidly confessed he did not think it was so.

The ports at present used for working 12-ton guns are very deceptive; they appear exceedingly small, when viewed from the outside, and, apparently, there is little room for the admission of shot or shell, but the fact is the ports are only small to look at. The edges are beveled away inside, so that there is nothing left except the external armour plate, to prevent the free admission of shot; the backing is all cut away, and practically the ports are very large.

I will, however, suppose that the present style of port is as strong for defensive purposes as it looks from the outside; and will grant to it all the merit it can claim on this score. From actual measurement in the "*Minotaur*," "*Northumberland*," and "*Bellerophon*," I find that the smallest port yet fitted for a 12-ton gun has an exposed area of more than 9 square feet. The exposed area of my port is 4.233 square feet, or in other words, less than half that of the ordinary port; consequently, when I have shown that my small exposed port does not cause me to lose any substantial advantage possessed by a larger one, but does give me many advantages which they cannot afford, I think I have achieved something in reducing 9 square feet of open port to less than $4\frac{1}{2}$. But, I apprehend, it was the supposed tendency to weaken the *structural* strength of the ship which was feared in the case of a port 4 feet wide; whereas, in truth, the port I propose cannot weaken the side of the ship so much as those already in use. It is very easy to say that my port is 4 feet wide, and the existing ports are little more than

2 feet wide, and therefore that the former must cut into the side (or in other words weaken it) twice as much as the latter, but this is not true, for there is a certain law, known to every mechanic, that the greatest strength of any structure is the strength of its weakest part.

Now, inasmuch as the edges of my port are square from outside to inside, the total extent to which the ship is weakened, longitudinally, is represented by the width of the port, viz., 4 feet.

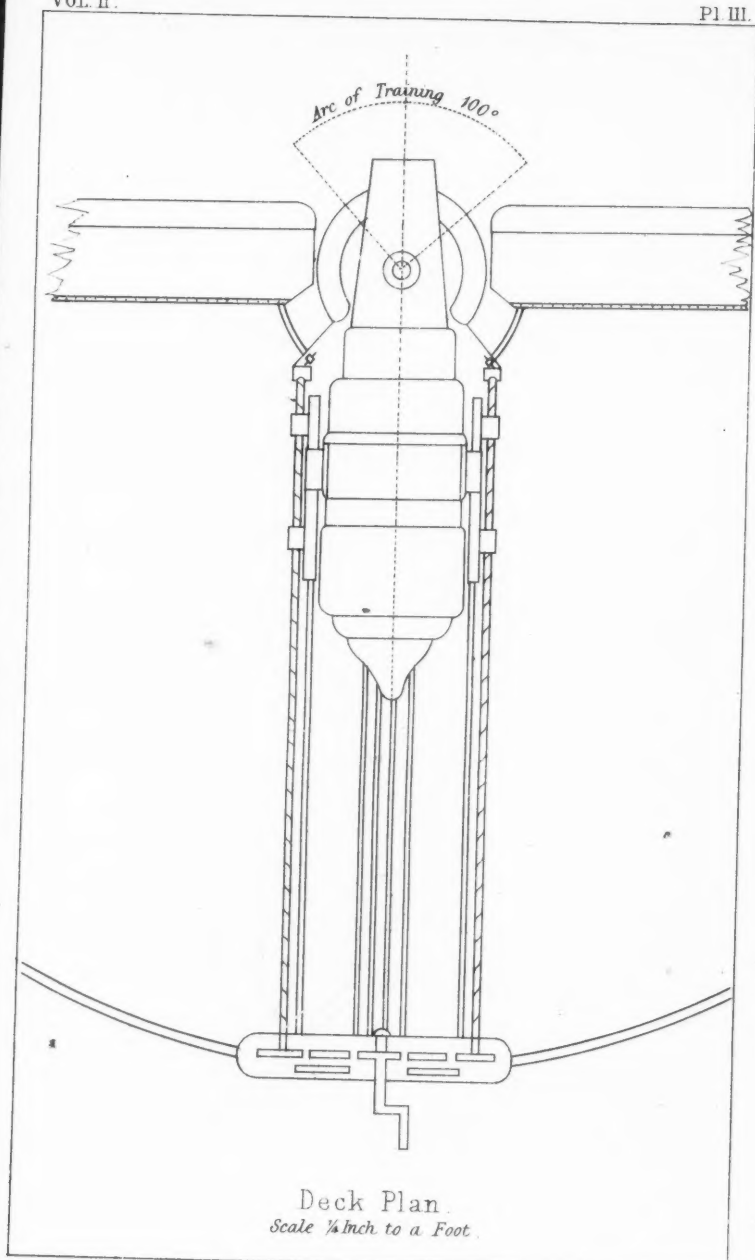
In the case of the ordinary port, the weakest part is to be found *inboard*, where, instead of 4 feet, the side of the ship is cut away to more than 5 feet, and this latter figure represents the real extent to which the side of the ship is weakened, for it must not be forgotten that the framework of the ship is *inside*, and it is the framework, and not the armour-plating or its backing, which gives strength to the structure. This being so, every inch which is cut away from the inside of the port, weakens the side of the ship to that extent; so that my 4 feet port, instead of being a source of *weakness*, as compared with the present style of port, is exactly the contrary in the proportion of 4 to 5, where the higher number represents the greatest weakness. I am aware that my port is somewhat higher than those in use, but inasmuch as I do not cut into, or interfere with, the main deck or upper deck beams, I do not in any way weaken the vertical strength of the ship.

Such, then, is the port I originally pierce in the side of the ship, and I have travelled rather out of my way to show that in doing this, I do not cause any local weakness, but the opposite! Within this port I place what I call a "broadside turret!" This turret is of a cylindrical shape, with a spherical head, and has its inner part cut away so as to be quite open to the fighting deck, but externally is a perfect turret. (See Plate III). Like a central cupola on Captain Coles' plan, this broadside turret revolves upon a pivot in its centre, carrying the gun with it, to the extent of lateral training which it is possible to obtain. The gun-slide and the base of the turret are in one piece, or, as it would be in practice, the slide would be firmly attached to the lower part of the turret, so that when the turret moves, the gun moves.

Both turret and gun are set in motion (for training purposes) by a winch, acting at the rear end of the gun-slide, where a raised framework of iron, less than the height of the gun at the breech, and protected from shot by the gun itself, would contain all the needful machinery both for training and running the gun in and out, which would simply be a winch fitted with multiplying power, and capable of being thrown out of gear as required.

The turret, gun, and slide may be considered as one machine, viz., as a lever of the second order, with the power acting at a considerable distance from the weight. The leverage would be so great, when the gun was run out for firing, that the *power* required for moving the machine (in other words for training the gun) would be exceedingly small, so small, that with the assistance of a winch, the strength of one man would amply suffice for the purpose.

The weight of the gun and turret (about 20 tons) would be almost



J Jobbins

entirely borne by the pivot, except when the gun was run in for loading, when of course the wheels of the gun-slide would take their share of the weight.

Accordingly I provide a hollow cylindrical pivot of about a foot in diameter from outside to outside, made of 4-inch iron; just such a pivot as Captain Coles uses for bearing the weight of his central cupolas, only about a third of the size, the weight to be carried not being much more than a tenth part of a central cupola with its guns. This pivot is perfectly protected from shot or accident by the lower part of the turret, and by the adjacent armour plates, so that it is almost impossible that the pivot could be damaged; for even if it were to be struck by a shot which had succeeded in penetrating the ship's side, it could hardly receive any injury. At all events the pivot I propose, and the protection I give it, is greatly superior to any pivot yet devised for working broadside guns.

The turret I employ is very small, being only 6 feet high, 4 feet in diameter over all, and 6 inches thick, and exactly fitting into the original port pierced in the ship's side, only leaving sufficient room for it to work. The turret itself is pierced just enough to admit the muzzle of a 12-ton gun, and to allow of its elevation and depression some 7° or 8° . The consequence is that the exposed port is so small (3 feet high and 1 foot 8 inches* wide) that the greatest possible amount of protection is given to the crew of the gun. It is useless to say, as some Naval Officer said on a former occasion, "we do not want our men protected," for the country insists upon having its men protected. Moreover, the greatest fire-eater will allow that he wants his gun and its carriage and the needful apparatus for working it protected, for if this precaution be neglected, all the bravery in the world cannot save the capture of a ship whose guns are disabled.

It will, therefore, be quite plain that my port, which has only an exposed area of 4.233 square feet, gives a much greater amount of protection for crew, gun, and its apparatus, than that afforded by the present ports fitted to the latest broadside ships, which have an exposed area of 9 square feet.

But, it may be said, you may purchase protection at too dear a price. To this I reply, that so far from this being the case, I actually obtain it without paying so much for it, as is paid by the existing ports for the small amount of protection they obtain. The elevation and depression would be about the same in both cases, but as regards the lateral training of the guns there is no comparison.

The existing style of port with its 9 square feet of exposed area barely affords 30° of training, making a total arc of training of 60° . My port, which I have shown does not weaken the side of the ship so much as an ordinary port, and which leaves only 4 square feet exposed for the admission of shot, nevertheless provides for the lateral training of the gun to the extent of 50° each way, making a

* Since the delivery of this lecture I have found that I must allow a few more inches in the width of the port, to allow of the aim being taken along the side of the gun.—A.A.W.D.

total arc of training of 100° , or about two-thirds as much again as the existing amount.

It is the easiest thing in the world to provide for a great amount of training, so long as you increase the size of the port; but in this plan, which I submit to you, I get the maximum of training, with the minimum size of port, both as regards the weakening of the ship and also the exposed area; consequently I sacrifice nothing at all in order to obtain protection, but on the contrary I gain in every respect. Two years ago I was told here that it was a matter of no great consequence, whether broadside guns were capable of great lateral training or not, as the double screw principle would speedily enable them to be trained everywhere. To this I demur, as I did then, as it is not fair in a *comparison of plans* to imagine the exponent of one plan as having double screws and the other not. If my plan be compared to the existing plan, then if the ship representing the latter has double screws, the former must also be supposed to have them, when I shall show that I still have the advantage.

But in point of fact, it is a very doubtful point whether in extremely long ships, like the "Agincourt" or "Warrior," the double screw principle would enable them to turn with sufficient rapidity to be of any service in working their guns, while at any rate, that ship which could train her guns through the largest arc, would require the least assistance from her screws, and therefore would be so much the more serviceable ship of the two.

Again, in any ship, whether short or long, the screws may be injured, or the engines disabled, and if this were the case in two ships engaging each other, then would come in the value of great lateral training of guns. The same advantage would hold good in the case of a ship attacking a fort, or choosing a position for attacking a vessel, in either of which cases the power of training broadside guns through an arc of 100° , instead of 60° , might very easily make all the difference between victory and defeat. This, by the way, is where the turret-ship proper is seen to its greatest advantage, by reason of the very large amount of training which all her guns have. My plan is to bring the broadside-ship as near the turret-ship, in point of training, as it can possibly be brought.

A recent experiment, made at Shoeburyness, has enabled me to show the great value which is to be attached to my method of working 12-ton 300-prs. on the broadside, so as to gain an additional 40° to the arc of training.

The experiment was that of firing at an improved "Warrior" target placed at an obliquity of 30° from a right angle, or in other words at the extreme angle of training possible to be obtained by any existing broadside-ship for all her guns.

The result of this experiment was, that the target was penetrated by a Palliser shot fired from the 7-inch Woolwich gun, the weight of which gun is only $6\frac{1}{2}$ tons.

Suppose, for an instant, that the target had been the actual "Warrior," and the gun had been fired from an enemy's battery. The "Warrior" could not have decreased the angle of obliquity her

sides made with the line of fire, without doing away with the possibility of answering the battery with her own guns. But suppose that the "Warrior" were fitted with my ports, and with 12-ton guns, she could then, with a slight touch of the helm, decrease the angle at which her sides were inclined to the line of fire, from 60° to 40° , and still be able to answer the battery with all her guns, and it remains to be proved that, at an angle of 40° , her sides could be penetrated by any gun in existence, notwithstanding the penetration of the improved "Warrior" target at an angle of 60° .

The least that can be said for my plan of providing a great increase of lateral training is, that I have all the chance on my side that no penetration would be possible when my guns were extreme trained, whereas the contrary has now been *proved* to be the case as regards the existing broadside-ships.

I do not know that anything further need be said about my method of *training* broadside-guns, in order to make it intelligible, except that in place of the ordinary kind of rollers, I should substitute flanged wheels for the gun-slide and also for the gun-carriage, so as to give steadiness.

The pattern would be something like a railway carriage-wheel, the size, that of the ordinary roller in use, except those at the rear end of the slide, which would be somewhat larger, and to these would be fitted a lever break, so that the training of the gun could be checked at any required point, and the gun fired without any chance of the slide shifting and thereby diverting the aim.

I still advocate the use of iron for everything connected with the gun and its carriage. Along the slide I would fit iron ways on which the wheels of the gun-carriage would rest and run with the least possible amount of friction, so as to facilitate the operation of running the gun in and out.

The best method of taking up the recoil of the gun, is I think, that employed in the compressors fitted to the competitive carriages of Sir William Armstrong and Captain Scott on board the "Bellerophon," both of which compressors, I am informed, work extremely well and are the inventions of the above-named gentlemen.

Before I pass away altogether from the subject of *training* guns, I wish to point out another advantage which my plan secures. It is that of closing the open port while the gun is loading, by turning it away from the point of firing.

In the ordinary broadside-ship, when the gun is fired and recoils, it leaves the whole of the port open, and until the gun is reloaded and run out again, the crew of the gun are completely exposed, whereas with my ports the fire of the gun is delivered, when a few turns of the training-winch causes the small open port there is to disappear entirely; and it must be remembered that if two ships are pretty nearly matched in speed, size, weight, and number of guns, that ship will eventually win the fight which has the greatest number of men left uninjured. A few well-directed shells exploding through open ports would soon reduce a ship's company to nothing, at which

point it is a matter of no consequence that the vessel has a number of splendid guns, if she has not the men left alive to work them.

I now come to the subject of running heavy guns in and out. On this point it has struck me that the present plan of using an endless chain passing over rollers, is singularly ill adapted to do the work required of it. Moreover, I cannot see how it can possibly be expected to work in a heavy sea-way.

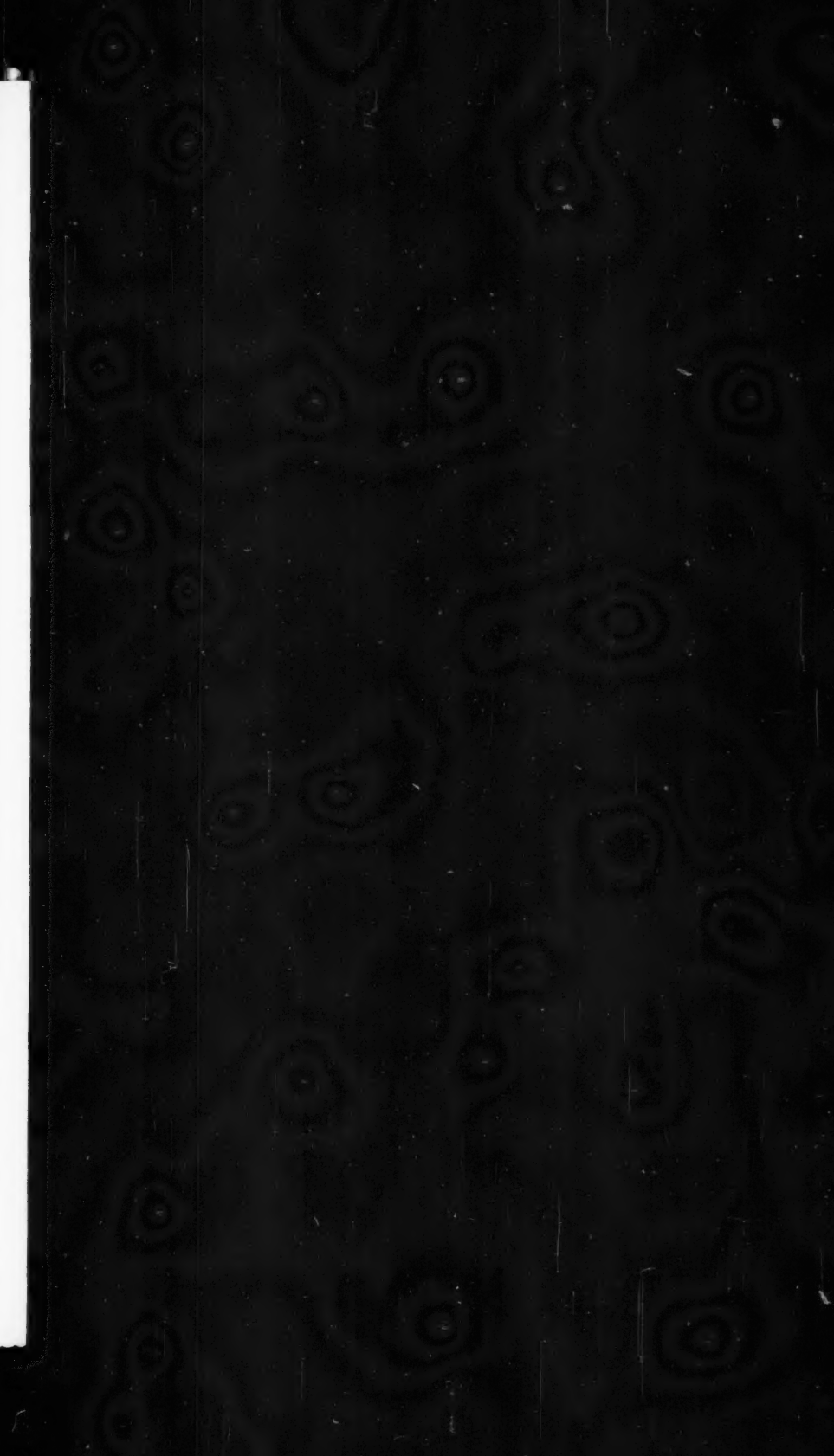
I have, therefore, devised a plan of running guns in and out, which plan I think will give perfect control over the heaviest gun, in the heaviest sea, and with the ship pitching and rolling to any extent.

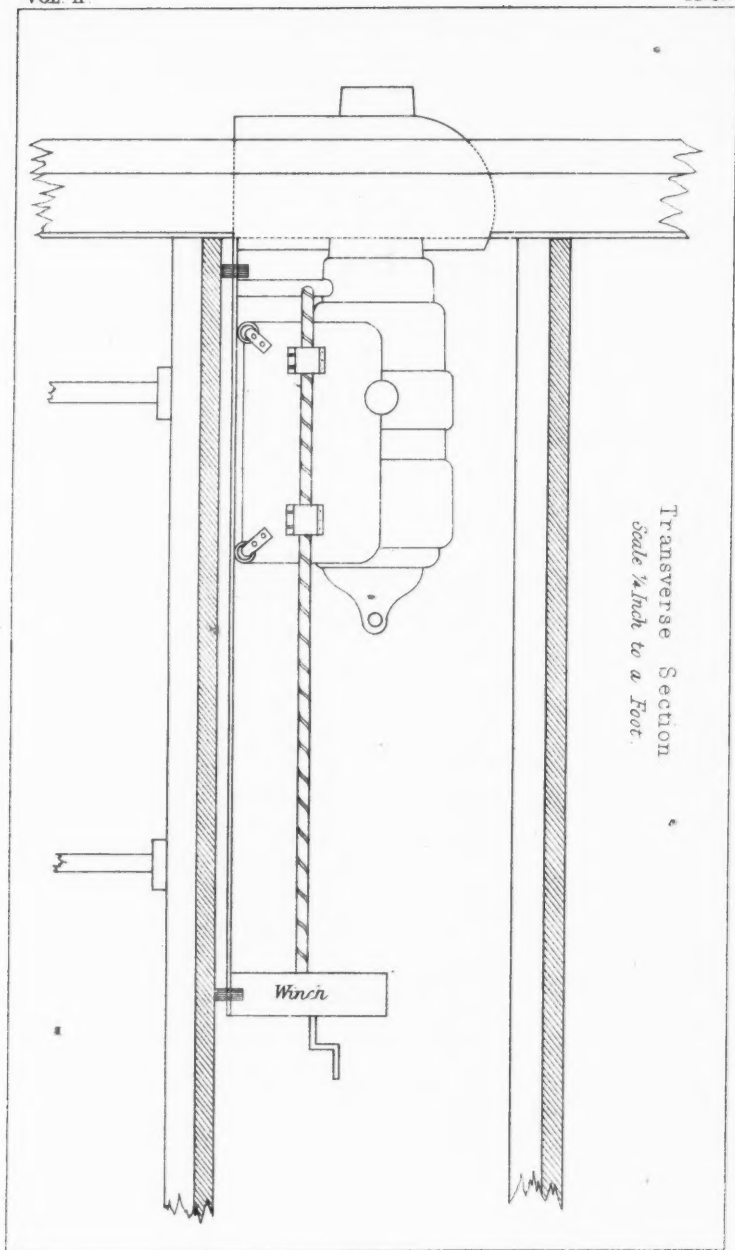
In the recent cruize of the iron-clad ships of the Channel Fleet, the much-vaunted "Bellerophon" was utterly unable to fire her guns when she was only rolling some 13°, and this, partly on account of her large open ports admitting so much water, and partly on account of the impossibility of running the guns out with the endless chain, which having a certain amount of slack, threatened at every lurch the ship gave, to allow the gun to "take charge."

A ship fitted with my plans would be open to neither of these objections; first, on account of the extremely small open port, and next on account of the firm hold and the perfect control which my apparatus would give over the gun in every conceivable position. Indeed so long as the muzzle of the gun did not actually enter the water at each roll, I would undertake, by a small addition to my port, to continue the accurate firing of the guns, when the "Bellerophon" would be making for the English shore; and if engaged with her in very rough weather, to sink her when she could not open a single port to return my fire.

Instead of an endless chain, I propose an endless screw, which will be seen at a glance (Plate IV) to afford a perfectly vice-like grip, so that the gun may, by the inexorable compulsion of mechanical force, be made to go out or in, with the utmost certainty and at the same uniform pace, no matter how much the ship is pitching and rolling about.

I provide two screws the length of the gun slide, one to be fixed on each side of the gun-carriage. These screws would be right- and left-handed, with a rather coarse, flat thread, and would be pivoted at both ends; at the rear end of the gun, in the raised framework which contains the training-winch, and the other end in a smaller framework attached to the slide. The screws would be set in motion by the same winch which trains the gun, the machinery being thrown out of gear for the one purpose and into gear for the other. The screws would work through boxes, fixed to the sides of the carriage, containing the matrix of the screws; and lest the rapidity of the recoil of the gun should endanger the stripping off the thread of the screws the boxes would be made in two pieces, so that by a hinge-like process the screws would be altogether disconnected from the gun while it was in the act of being fired. In Plate I, I have placed the screws rather high up, and for this reason, they are protected by the turret from injury by shot, and the fact of their being in the position shown will secure great steadiness for the gun when the ship is pitching. They might





however as easily be placed lower down, and I may be told "that in their present position, they would be decidedly in the way of the "men loading the gun;" but this is not so, as there would be sufficient room for a man to pass between the end of the screw and the turret. But if the position of the screws at the sides of the carriage were to be found inconvenient, one single screw would suffice, and this might be placed in the middle of the slide, just clear of the under part of the gun, and still as before the same winch would do the double work of training the gun and running it in and out.

It may be thought that although the screw is a very powerful piece of mechanism, it is slow in its action, and so it is by itself; but connected with a winch with multiplying power, the screws I propose would not have the disadvantage of being slow in their action; on the contrary, I should anticipate that with the above named machinery, a 12-ton gun could, even in smooth water, be run out and in more quickly than is now possible with an endless chain, while in a heavy sea there would be no comparison whatever.

In summing up the description of these plans I claim and can prove that I was the first to suggest the training of heavy broadside guns by machinery placed at the rear end of the gun-slide; indeed when I introduced that idea two years ago in this room, no such plan had been adopted in the Navy; but long before that I had made it known, and I have in my possession a letter from the present "Chief Constructor," bearing date September, 1863, and another from the present First Lord, in both which letters my plan is referred to. I have also a tradesman's bill, dated July, 1862, for the construction of a model illustrating the whole of these ideas of mine, except that of the endless screw for running guns in and out, which I have only lately devised.

And now I will bring this paper to its conclusion, with an apology for its rambling character, only observing that being the incumbent of a large and poor suburban district, and having for many weeks past had nearly 500 poor families in utter destitution, and looking to me for help, I have been prevented by almost incessant work, night and day, from devoting any time to its more careful preparation and revision, for with me these things are matters of amusement and recreation rather than work. I am quite sure therefore that this paper must be full of verbal inaccuracies and errors of construction, but I trust you will pardon all these faults when you know the cause of my hurry. Having promised some months ago to prepare and read a paper upon the working of heavy broadside guns, and being set down in your printed programme to do so, I have endeavoured, as best I could, to keep my promise, though I have been obliged to snatch my time for doing it principally after twelve o'clock at night.

If I have omitted any material point, or have not made my ideas clear to you, I shall be very happy to answer any questions you may desire to put to me. I thank you much for the attention you have given me, both on the present, and also on the former occasion when I had the honour of appearing before you.

The CHAIRMAN: We thank Mr. Drew for the paper which he has just read to us. It displays great ability, and I hope some of the gentlemen present will give their opinions respecting it.

Commander DAWSON: I think we must all be pleased with this paper which is excessively clear, and which Mr. Drew has taken the pains to come forward and read. I rise rather for the purpose of eliciting more information, than for the purpose of finding fault. It appears to me that, by cutting away the bottom of the turret and reducing the waste part, you would not cut away so much of the ship's side. By cutting away the ship's side only one half that height, you might do away with what appears to me to be the waste part of the turret.

Mr. DREW: The lower part, that would place the muzzle of the gun so near the water?

Commander DAWSON: I mean, keep the gun the same height, but cut away the turret, and replace the ship's side up to the gun, so that your port instead of being the present height, would be half the height. But the gun would be the same height from the water, only you would reduce the lower part of the turret.

Mr. DREW: I should have done that, but I was unable to devise a good scheme for connecting the turret with the gun slide.

Commander DAWSON: I am not very clear, as a second point, how the salt water is to be kept out. It appears to me that the water would come in all round the turret; that is, between the turret and the ship's side, and of course through the port itself, unless you had some means of stopping it. I dare say you have means, but it does not appear very clear how you are to keep the water out.

Mr. DREW: I have devised a scheme for that, a circular boiler plate, for sea-going purposes fixed over the exterior of the port, and up to the level of the lower part of the gun, and another part to fit down over it, to be removed in actual warfare.

Commander DAWSON: That is very satisfactory; still, in the supposed case you gave us of the "Bellerophon" in a gale of wind, with a sea coming in, where we have a plan—certainly a very rough plan, I cannot say altogether a very feasible one—in which we can lower the ports and fire between the seas, it appears to me you could not adopt a plan of that kind with your turret, because the water must come in round the turret very largely indeed, particularly if you bring the port so much nearer to the water line than it is in the old port. That you could remedy, by reducing the lower part of the turret by cutting it away, and bringing the ship's side so much higher, you would thus do away with that objection to the turret.

Mr. DREW: The fact is, that the model at which you are looking, has been in the Institution since my last lecture, in 1865, and I have not had the opportunity of adding that to it which arose out of the discussion last time. I had thought previously of that plan, which would at all events bring the lower part of the port-sill higher up than in the "Bellerophon." I should propose to fit that circular boiler plate as a permanency for the purpose of keeping the sea out; and in a gale of wind I should drop down the other part over it.

Commander DAWSON: Now, with reference to the carriage, yours seems a very ingenious and simple arrangement for running in and out, and training the gun. You disconnect the screw from the carriage when the gun is fired, which gets rid of the first difficulty suggested to my mind. One is not perhaps enough accustomed to these guns to speak with certainty, but it seems to me that if a shot were to knock away the machinery, it would be difficult to repair such damage. You might get over it by the use of tackles. It seems to me that this traversing gear is not very different from that first used by Sir William Armstrong some years ago. He brought it out for breech-loading guns some five or six years ago. I do not see any other objection to that part of the invention, which appears very nicely got up.

Vice-Admiral CODRINGTON, C.B.: Is the screw entirely liberated from the carriage when the gun is fired?

Mr. DREW: Entirely.

Admiral CODRINGTON: Because if not entirely liberated, it is as bad as if not liberated at all. There is another point I would remark upon. I think you have not contemplated the jamming of your turret by a shot. The gun would, I think, be more likely to be disabled from jamming in your turret than in the present turret. I think you mentioned that you keep the side of the port square?

Mr. DREW : Yes ; the edge of the port.

Admiral CODRINGTON : But suppose you were to extreme train to an angle of 50° one way, marked by the red lines on your diagram, and then to extreme train the other way, also marked by red lines, all that is not occupied by the red lines might be filled up by the strength of the ship, thereby reducing the port still more.

Mr. DREW : The line shows the centre of the gun. The gun will almost touch the edge of the port, and there is no room left. You see that the gun is made almost to touch the port.

Admiral CODRINGTON : But if you train the other way there is an angular space. It was an argument many years ago that in all our old ships that piece ought to be filled up with timber, and in the present day it might just as well be filled up. So, I think you might modify your plan of having it square, by simply taking what you want for the position of the gun, extreme train one way, then extreme train the other way, and then you will find a vacant angle on each cheek of the port, which you might just as well fill up by strengthening the ship's side.

Mr. DREW : That would certainly strengthen the port, and reduce it. The case of jamming I had thought of, and provided against. The working of the gun could not be stopped by jamming, unless both sides were jammed at once, which is extremely unlikely to happen. The leverage is so great that I have simply to heave round the winch in order to drive out a wedge or other obstruction.

Admiral CODRINGTON : As to that, it seems to me that the whole of the motive power will depend upon one winch, and I should be very glad to have reserve tackles to fall back upon.

Mr. DREW : The length of the slide is about sixteen feet. The weight of the whole apparatus is thrown almost immediately over the pivot ; and it being a lever of the second order, the power acting at a great distance from the weight, the power required for training will be extremely small. In fact, in practice, I should not wonder if you could push it along.

Admiral CODRINGTON : I am not speaking of the power, but suppose the winch were carried away.

Mr. DREW : If the winch were carried away, you could push it along. At all events, temporary training tackles would do it.

Admiral CODRINGTON : You propose a slide and pulley.

Mr. DREW : Yes.

The CHAIRMAN : We are all very much obliged to you for having brought this subject forward. I cannot but believe that in so doing you have been doing public service, and I hope it will receive that attention which it deserves.

LECTURE.

Friday, February 15th, 1867.

MAJOR-GENERAL SIR FREDERIC ABBOTT, C.B., Member of
Council of Education, in the Chair.

A NEW METHOD OF IMPROVING THE MEMORY AND FACILITATING THE ACQUIREMENT OF KNOWLEDGE.

By Dr. EDWARD PICK.

I HAVE been occupied for some years in this country in teaching a method of improving the memory, or rather of facilitating the acquirement of knowledge. This method is based upon a principle different from that generally admitted. The fact is, we think that it depends upon the memory, if remembrance is easy or difficult. Now, I think that memory has very little to do with the facility or difficulty of remembrance. This may seem paradoxical; at any rate it will be a consolation for those, who have bad memories. But I think I have only to draw your attention to our daily experience to show you how little memory has to do with the facility or difficulty with which we remember. Not those things which we committed to memory are the easiest to be remembered. There are things which we saw, or heard, or experienced, once in our lives, and which we never forget, whereas things which we have committed to memory, very soon pass out of remembrance. You will hear old people say that they recollect things of their youth, sometimes 60, 70, or 80 years ago, and that they are not able to recollect things of yesterday. This is another proof that memory has nothing to do with it. Because if it were loss of memory with old people, it ought to be much easier to recollect recent things than very remote ones, but just the contrary takes place. We endeavour sometimes to recall certain ideas to the mind, and notwithstanding all our efforts we are not able to do it, and we find, that those same ideas later, come suddenly back, without our co-operation, even sometimes against our will. All this would be impossible if memory had anything to do with it. If I have a good memory for proper names, for instance, I ought to be able to remember a name whenever I want to do so, but there is no reason why I should not be able to recall to my mind a certain name, otherwise quite familiar to

me, and why that same name later suddenly should come back, without my co-operation and even against my will. The reason of all this is, that memory is the faculty of the mind to recall, or rather to have back, ideas, which were there once before, but the facility or difficulty with which the ideas come back, depends entirely upon a simple process, going on in our minds not when we remember, but when the ideas first come to the mind. This process is no new discovery, the great Aristotle has already fixed the laws of the reproduction of ideas. Nevertheless this law, which is a very simple one, has been practically overlooked, just because of its simplicity, and we have done and do our best to oppose it, and consequently to impede, instead of aiding the natural functions of the mind. I shall endeavour to explain the law by which we remember, and to show that in paying attention to the very simple reasons why we remember certain things, whereas we forget others, we are able to strengthen our memories to an almost incredible degree, without applying those cumbersome artificial means, or so called mnemonics, which present means more difficult to overcome, than the things they aim at mastering.

Before I explain the theory, and show its applications, I will venture to lay before you some of the results, which can be obtained with it. And in order to show as much as possible in one instance, I shall choose numbers, because numbers are always regarded as the most difficult to be retained. You know how little hold they present to the mind. I will therefore show at once, with what facility even larger numbers can be impressed on the mind. The easiest way to read a number of 60 or 80 units, is to divide them at their proper periods of thousands, millions, billions, and so on. We will group together a number of units, taking always three at the time.

[The lecturer marked off a black board into 25 compartments which he numbered and then continued:]

In inscribing three units in each of those compartments, we will be able to group together 75 units; and in order to show you that the difficulty is not very great, we will not fill up those compartments in their regular sequence, but quite at random. Be so good to mention always three units at the time and indicate the compartment in which they are to be inscribed.

[The following figures were then given by the audience and written down on the board by the Secretary:—

111, 298, 456, 756, 749, 540, 359, 634, 958, 972, 861, 846, 531, 167, 384, 234, 786, 296, 980, 157, 536, 573, 715, 762, 873.

The lecturer then repeated the figures from the first to the last, and then backwards, and afterwards indiscriminately, the number of the compartment being given, he named the figures inscribed in it and *vice versâ*.]

After this he continued:

I could extend those tests to proper names, words, phrases, and so on. But as my intention is not to show feats of memory, but rather to explain how memory can be improved, instead of continuing those exercises, I will now proceed to explain my theory.

We know by experience that those things, which make a strong im-

pression agreeable or disagreeable, are always easily remembered, whereas indifferent things, or such as we have paid but little attention to, pass out of remembrance, in other words we find that those ideas, which came to the mind with a great strength, always come back easily.

I need not say, that the things we see, we hear, or read, &c., are all ideas coming to the mind. We know by experience, that if ideas come to the mind, they generally find other ideas present, but they usually expel those they find there, and also recall others. So, *e.g.*, if I now succeed in fixing your attention to what I say, all other ideas will disappear from your minds for the moment. This is generally but not always the case. Sometimes the ideas which were present before, do not disappear. The fact is, that like in the physical world, where the stronger beats the weaker, you will find, that stronger ideas always beat weaker ones.* If those ideas, which come to the mind are stronger than those they find present, they will make use of their strength and expel the weaker ones. This is shown in the fact, that if one thing attracts our attention, all other ideas disappear from our minds for the moment. But if the ideas which try to come to the mind find others present which are stronger, then those latter ones make use of their strength and do not admit the new comers, they repel them immediately. This is shown in the fact, that if something preoccupies us, we neither see nor hear what is going on around us, though we are in the same physical condition, as we were before. Our eyes and ears are open, but the ideas trying to come in through those channels are repelled by the strong ideas present in the mind. A very striking proof of this action and reaction (as it is called) of ideas in the mind, is of daily experience. You are sometimes occupied with something which absorbs all your attention. Say, for instance, you read a book, which you like very much, there may be other people in the same room talking, or even playing music, but you neither see nor hear anything because the book absorbs your attention. But sometimes you suddenly stop, because you have just observed that you do not know what you have been reading about in the last ten or twenty lines, and you must read it again to know what it is. This will happen if chance brings to the mind an idea, which is stronger than those coming from the book. As long as the book fixed your attention, nothing else was admitted. But a word spoken, a noise heard, or even sometimes an idea recalled to the mind by the book itself "crosses the mind," in other words, an idea appears which is stronger than those coming from the book. From that moment nothing else is admitted, and this is why you do not know what you have been reading about in the last ten or twenty lines.

If two ideas are in the mind of which one is stronger than the other, the stronger one will expel the weaker one. But suppose two ideas of equal strength in the mind, what will be the result? Again, like in the physical world, if the two ideas cannot fight each other, they will shake hands, that is to say, as one cannot expel the other, they will blend together. This blending of ideas, which is constantly going on in our minds, is not only the basis of remembrance, but of all intellec-

tual activity! Because we know by experience, that those ideas which blended together in our minds, if, later, one of them comes back, or if we recall it, it will recall the other with which it blended, and this recalling of one idea through another is remembrance or recollection, for, with the slightest attention you will find, that an idea never comes back to the mind by itself, but is always recalled by another. The facility or difficulty, with which one idea recalls another, depends upon the strength with which they blended together. If there was a strong blending, there will be an easy recollection, if there was a weak blending, there will be a difficult recollection, if there was no blending, there will be no recollection.

The strength of the blending depends upon the intrinsic strength of the ideas. Strong ideas will blend strongly together.

This theory explains all the phenomena cited above, in connection with memory. We do not forget certain things, though seen, or heard, or experienced only once, because when they happened, they made a very strong impression, in other words, they came with a great strength to the mind, and blended strongly with other ideas. This is why they come back easily. Old people recollect things of their youth, because those things made a strong impression when they first came to the mind, blended strongly with other ideas, and consequently are always easily recalled.

We have nothing to do with those blendings, they are going on in our minds without our co-operation. The proof that it is so, is the fact, that we cannot forget things which we would like to forget; those things when they happened made a strong impression, we did not like the impression, but we could not help it.

As the facility or difficulty of remembrance depends upon the strength with which ideas blend in the mind, the only means to strengthen the memory or rather to facilitate remembrance, is not to deal with memory at all, but to find means to strengthen ideas which are too weak to make an impression. I have not to offer you new means which I have discovered, or very complicated means to strengthen impressions, on the contrary, I apply very old and very simple means, which everybody applies more or less. But I venture to say, I shall show you some new results, which you will obtain with very old and very simple means. I need not say, that these means are taken from experience. We know by experience, that if there are too many ideas at the same time in the mind, they weaken each other. If we try to think of too many things at once, we forget everything again in a very short time. The first means therefore I recommend to facilitate remembrance, is to concentrate our attention to as few ideas as possible at the same time, because, the fewer ideas there are at the same time in the mind, the stronger they will be, and consequently the stronger the blending.

Another very simple means to compel our attention, because this is all, is *comparison*. Because if I compare two things, I am compelled to pay equal and exclusive attention to the two things which I compare. The trouble I take to seek their connection strengthens them in my mind, and consequently they will blend strongly together.

If later one of them comes back to the mind, or I recall it, it will recall the other with which I compared it. These recollections are so easy, that, as you know, not only things which we compared, but even things which we never compared, but which bear a great resemblance, or a great analogy, recall each other.

These are the two simple means—I may say the two exclusive means—which I endeavour to show, we can apply to whatever we have to learn by heart, or to keep in mind, viz., first; to concentrate our attention to as few ideas as possible at the time, and secondly; to compare.

If I say compare, there is sometimes no necessity for comparison: I mean in such cases where the connection is obvious. Take for instance two ideas, like book and printing. There, is of course, not the slightest necessity to seek the connection of those two ideas. In such a case it is quite sufficient to concentrate our attention for one moment only, so that they may blend strongly in our minds. Usually we are recommended to associate ideas, that is to say to combine them to a picture or an arbitrary connection, *e.g.*, you would say a book printed, &c. But you will find, that if we associate ideas, we spoil the *real* association, that is to say, the blending going on in our minds without our co-operation, which I endeavoured to explain before. I will show how strong those associations are if we do not meddle with them, if you will allow me to give you a series of ideas. I shall always mention two ideas at the same time, their connection will be obvious; you will therefore kindly pay one moment's attention only to the two I name together, but you will please in going on, never to pay any more attention to the preceding ones. Dismiss them entirely from your mind.

The lecturer then named the following ideas:—Book—printing, printing—newspaper, newspaper—telegraph, telegraph—Atlantic cable, cable—America, America—cotton, cotton—Manchester, Manchester—Sir Robert Peel, Sir Robert Peel—free trade, free trade—navigation, navigation—Australia, Australia—gold, gold—jewelry, jewelry—fine arts, fine arts—picture gallery, picture gallery—Trafalgar-square, Trafalgar-square—lions, lions—zoological gardens, zoological gardens—animals, animals—hunting, hunting—breech-loaders, breech-loaders—needle-gun, needle-gun—Prussia, Prussia—Rhine, Rhine—wine, &c.

If you have concentrated your attention always to the ideas only I named together, there were always two ideas only at the same time in your minds, the connection was obvious, consequently they were very strong, and blended strongly together; that is to say, the first blended with the second, the second with the third, and so on, and the proof that they so blended, is that if I now give you again the first, or if you recall the first, it will immediately recall the second; the second coming back, will recall the third, the third the fourth, and so on. The first recalling the second only, and so on, none will fail. More than this, you will find that not only the first will recall the second, and so on, but one of them taken at random will recall all the others. If, *e.g.*, you take the last, that last will recall the one before, because it

blended with it; this again the one before, and so on; so you will recall them backwards with the same facility as forwards.

[The experiment was made by the audience, and succeeded completely.]

Another advantage of that simple means to pay attention to two only at the time, is that the difficulty does not increase with the number, as we never have to pay attention but to two, notwithstanding the number.

This can be applied each time we have a series of words to learn by heart. If a series of isolated words is to be kept in mind, the task can be accomplished in different ways. In some cases it is necessary to know a series of words in precisely the same order in which they are given; in other cases the order of the words is of no importance. In cases of the latter kind we can arrange the words ourselves, so as to take always two together, which we can easily compare. We are thus able to make of it a series of connected ideas, like the above given. If we have such a series, one perusal will be sufficient to impress it on the mind, if we never pay attention but to two. In neither looking backwards nor forwards the difficulty never increases with the number. I found that this way of arranging isolated words is of great assistance in such cases as in grammars, where we have exceptions to learn, for I found that this method of learning them teaches us at once not only the exception, but the rule too. If you allow me, I will give you a practical instance. The words I just gave were the first words I found, in which I was sure you would see a connection; but I will now give you a series of words, which most of us had to learn in school, and which I am sure we have mostly forgotten again. I will first give the words, and afterwards tell you what they are. You will please again to pay attention to two only at the time, which I name together:—Mullet—fish, fish—river, river—channel, channel—ditch, ditch—worm, worm—dust, dust—footpath, footpath—hillock, hillock—stone, stone—fire (because of flint), fire—firebrand, firebrand—bellows, bellows—ashes, ashes—fine flour, fine flour—bread, bread—cucumber, cucumber—stem, stem—thorn, thorn—bundle, bundle—club, club—lever, lever—axletree, axletree—ploughshare, ploughshare (emblem of peace)—sword (emblem of war), sword (artificial weapon)—nail (natural weapon), nail—blood, blood—snake, snake—dormouse, dormouse—net, net—hair, hair—rope, rope—collar, collar—circle, circle (orbis)—month, month (division of time)—end, end—door-post.

[The audience then repeated the whole list with the greatest facility and precision.]

These words are a series of exceptions, which we had to learn in the Latin grammar. You remember the rule, that all nouns of the third declension in *is* are feminine, with the exception of about 36 or 37 words.

The words I just gave are those exceptions. You remember the trouble we had, and the time it took, to learn those words, and even after having learned them well, we soon forget many of them; at any rate, if one of those words occurs, we are not always sure if it is an exception or not. But with my method it is just the contrary. Not

only it takes no time, it requires no effort to impress such a series on our minds; but you will find that if we take the trouble to go through such a series once or twice more, they will be indelibly impressed on the mind. For if afterwards we want to know whether a word is an exception or not, we have not to go through the list, but the word itself tells us if it is an exception, as each of those words recalls the preceding and following one, and is therefore immediately recognised as belonging to the series. I am sure it does not take you one moment's reflexion to tell me if the words *sword, fish, end, net, &c.*, were in the list. If, therefore, I find that the word is a word in *is, ensis, piscis, finis, cassis*, I directly recognise it as an exception. More than this, if a word occurs which is no exception, the word itself tells me that it is regular, because it does not recall others of the list, is therefore not in the series of exceptions. I found that this method of arranging exceptions, enables students of the French language to know the genders of French nouns with great precision and certainty.*

I gave the English equivalents of the Latin words, because I had to do with the idea the word expresses. If we know the Latin word, it is of course quite indifferent if I say *mugilis* or mullet, *piscis* or fish, &c.; but if we do not know the Latin words, they cease to be an idea. It requires, of course, some more time, generally five more lectures, to show all the applications of the principles which I have the pleasure to lay before you to-day; then I show, of course, how to apply it to foreign languages. But to-day I may be allowed to add a few observations only about some other practical applications of my method. My principal means to facilitate the acquirement of knowledge is, as you have seen, comparison. But in comparing, it is most essential to take *the known* as a basis of comparison for *the unknown*; whereas, usually, we do the contrary. I tried to apply this principle, *to go from the known to the unknown*, to the study of foreign languages, and I will here explain the fundamental idea which I have fully developed in my books "on Memory" for the German, and "on language" for the French.

The general way adopted for the study of a language is to begin with the alphabet, the reading, and the grammar; that is to say, to learn unknown details, unknown particulars of a thing equally unknown; whereas the easy and natural way would be, to start from known things, and to compare the unknown with it, as far as possible. I have for many years practised the application of this principle, and have obtained astonishing results. I give first those elements of the foreign languages which are to be found in our own language; the unaltered ones first, then the altered. In pursuing the laws by which the different languages have been formed out of others, and are progressing still, it is very easy to give to the pupils a great number of elements, not only of words, but of whole sentences, &c., which would be identical with or analogous to the words and phrases of his own language. Thus the pupil is introduced, in a very easy way, directly into the very life of the language he intends to learn, without any

* See Dr. Pick: A New Method of Studying French. Trübner and Co.

mechanical labour of the mind, more by comparing and reasoning. He soon gets accustomed to the changes the same roots undergo in analogous languages; and having in this way learned a small piece of prose by heart, he will find in this piece a great number of the rules of the grammar applied, consequently known to him without having been aware of it. So he goes always from the known to the unknown by comparison and reflection, and he very soon becomes master of the foreign language, without much trouble, and in a surer way than the usual one, because the association of analogous ideas, which is always going on, assures their reproduction for the future.

I have also tried to apply those principles to the teaching of writing and reading. If, instead of beginning with the letters, you begin with something known, you will see how soon the pupil becomes interested in the subject, and, consequently, how quick his progress will be. Anything the pupil knows by heart, is *the known* to begin with. Your Military Authorities gave me an opportunity to try this method with some soldiers of the Guards. As I supposed that they knew the Lord's Prayer, I took this as *the known* to start from. The pupil knows by heart the words, "Our Father, which art in heaven." If, therefore, I show him those words printed, or on the black board, and tell him the first word is "our," the second "Father," and so on, he will repeat them at once. I take then each word separately, show in different places and amongst other words, until the pupil recognizes some, and, by-and-bye, all. I give him a slate and tell him to imitate the word on the slate, which he very soon accomplishes. He first learns the whole word, and then the details. So he learns reading, writing, and spelling at the same time, and one assists the other. I had the soldiers, about 15 to 18 men, 30—40 times, about an hour each time. Unfortunately, they had to leave London for Aldershot, and I was unable to continue; but I am convinced that it would not have taken more than another 30 or 40 hours to enable them to read and to write fluently and correctly.

LECTURE.

Friday, March 1st, 1867.

LIEUTENANT-GENERAL SIR GEORGE ST. P. LAWRENCE, K.C.S.I.,
C.B., in the Chair.

"THE SIKH AND EUROPEAN SOLDIERS OF OUR INDIAN FORCES."

By Major-General VINCENT EYRE, C.B., R.A.

MUCH has been said and written during the past year about employing a portion of our Indian Native Regiments, more particularly those composed of Sikh and other Punjabees, in assisting to guard our Colonial possessions in various parts of the globe; some having gone so far as to advocate their employment in Europe, and even in England itself; and as these suggestions have apparently emanated from persons more or less acquainted practically with the constitution and temper of those troops, and have excited considerable attention in this country, it is highly desirable that they should be carefully examined and sifted by competent men both civil and military, for which this valuable Institution affords such favourable opportunities, in order that such facts and arguments may be elicited as shall place the matter, in its various aspects, clearly before the public.

Should time admit, there are some other equally important and not less interesting questions connected with our Indian forces to which it is my intention to allude. We seem, indeed, to be on the eve of great changes in our military system both at home and in India, to suit the novel requirements of the times in which we live; and it appears to me desirable that the members of this Institution, comprising so many experienced officers of all grades and services, should, as far as in them lies, cast their ideas into the general stock, and thus supply a few of the necessary materials wherewith to build up a new edifice for the benefit of their common country.

For these reasons I have been induced, at the instigation of some members of our Council, to pen these few paragraphs, not from any assumption on my part of any better claims to attention than a career of thirty-four years of continuous active service in India may fairly entitle me to, but solely for the sake of promoting some opportune and profitable discussion, and of stirring up other more competent gladiators to the combat.

Let us then consider, in the first place, the adaptability of the Sikhs and other Punjabee soldiers for the purposes already suggested. Few require to be informed now-a-days about the origin and history of this famous race of warriors; the bravest, the hardiest, and the most formidable with whom the British forces in India ever came into conflict. It may be as well, nevertheless, by way of remembrancer, to give a brief preliminary sketch of the rise and progress of this remarkable people, that we may be better prepared to estimate their present and future value as supporters and defenders of the British rule, to which they now owe allegiance.

Centuries before the English appeared on the scene, the Punjab had been a battle-ground between Mahomedans and Hindoos. In these latter times the population has been estimated at ten and a half millions, of whom two-thirds are Mahomedans and the remaining third Sikhs and Hindoos. The Sikhs were, indeed, originally Hindoos themselves, but towards the end of the 15th century, under the stirring teaching of their great apostle NANUCK, and to a still greater extent two centuries later under that of his saintly successor, the great Sikh Reformer GOVIND GOOROO, they renounced the trammels of caste and the debasing practices of idol worship, and formed themselves into a military sect, in religious subjection to the doctrines and guidance of the latter, as set forth in the holy book known as the "GRUNTH."

The term "Sikh" means simply "disciple," and the surname of "Sing" or "Lion," which they universally adopted, was meant to denote that soldierly prowess on which they chiefly prided themselves, and for which they soon became so distinguished. Under the influence of a less degrading faith (somewhat resembling pure Deism), more substantial fare, and the martial spirit which was ever kept alive, they became more robust and enterprising than the Hindoos, and gradually their speech became distinct from that of their surrounding neighbours, of which it is a corrupt medley. Captain Cunningham, in his interesting, though somewhat too partial history of the Sikhs, thus writes of them in 1849: "A living spirit possesses the whole Sikh people and the impress of GOVIND has not only elevated and altered the constitution of their minds, but has operated materially and given amplitude to their physical frames. The features and external form of a whole people has been modified, and a Sikh Chief is not more distinguishable by his stately person and free manly bearing, than a minister of his faith is by a lofty thoughtfulness of look which marks the fervour of his soul and his persuasion of the near presence of the Divinity." Wilson, a less enthusiastic admirer of the Sikhs than Cunningham, describes them as still to a certain

extent Hindoos, celebrating all the festivals of the latter, and paying great veneration to Brahmins. However that may be, we must, at all events, give them credit for having made a very considerable stride in the right direction, and far in advance of the great mass of their countrymen.

At the close of last century, Runjeet Sing, the famous "Lion of the Punjab" became ruler of Lahore, and rapidly extended his dominion over the land of the five rivers. His conquests would probably have spread over Hindostan also, but for the growing power of the British which he had the sagacity to appreciate at its true value. In 1809 he concluded with them a treaty, pledging himself to keep west of the river Sutlej, which treaty he faithfully kept. He died in 1838, leaving behind him a most formidable army, which having been trained and disciplined under the teaching of able French officers, became a powerful instrument for evil in the hands of his weak and incapable successors.

With no master mind competent to command respect and obedience, these Prætorian bands soon burst the bonds of due control and assumed the part of dictators. Filled with overweening confidence in their own strength, and, above all, in the invincibility of their numerous and magnificent artillery, encouraged moreover by a remembrance of the recent reverses suffered by the British in Afghanistan, and, more than all beside, thirsting for the plunder of the rich and tempting plains and cities of Hindostan, which raid they had sworn sooner or later to accomplish, this ungovernable host suddenly assumed the offensive, and without any just or adequate cause of quarrel, crossed the Sutlej in immense force to try conclusions with their British rivals.

Fortunately the supreme power at this dangerous crisis was in the hands of an experienced soldier statesman equal to the emergency, and aided by a military chief of kindred spirit, whose career in many a hard fought field had been one of unvaried success. Hastily collecting all the available forces from the frontier stations, these two noble leaders advanced in person at the head of their troops to meet the invading foe. Throughout all India it was felt that the long foreseen struggle for mastery between the two great rival military powers of the period was on the eve of accomplishment.

At Moodkee the first shock of arms took place, but with no more decisive result than forcing an advanced division of the invader to fall back on the main body in a strongly intrenched position about 20 miles south-east of the British extreme frontier station of Ferozepore. Then followed the great and terrible battle of Ferozeshah, and never was the sceptre so nearly wrested from our grasp as on that hard-fought field. True we were considerably outnumbered both in men and guns, but not more so than had been invariably the case in former wars with other native powers, over which we obtained comparatively easy triumphs.

Never, indeed, had we taken the field in India with so powerful and well equipped a force. Yet the night of the 23rd December, 1845, closed over a drawn battle, each army holding its own ground till the

following morning, when the struggle was renewed; and so critical was our position at one period, that the question of retreat was seriously mooted, but vehemently opposed by Lord Gough, as fatal, in its probable consequences, to the British rule. Happily, this determination of their veteran chief to maintain his ground at all hazards was shared by every British officer and soldier on the field, and eventually turned the long trembling balance of victory in our favour. The victories of Aliwal and Sobraon, which soon followed, rolled back the tide of invasion from British territory, and enabled us to dictate a treaty under the very walls of the Sikh capital.

But it required more than one campaign to convince the Sikh soldiery of the hopelessness of the struggle on which they had so recklessly entered. They were temporarily repulsed and checked, but very far from being really humbled. Within less than two years a great Sikh army was again in the field, with an array of guns little less formidable than before. The siege of Mooltan, followed by the bloody fields of Chillianwalla and Gujerat, again testified to the indomitable pluck and energy of these sturdy Punjab warriors. Chillianwalla was a series of desperate disjointed struggles or episodes, which took place very much at haphazard, but with little appearance of combined action, and with many strange fluctuations of fortune, during which the Sikh cavalry exhibited a degree of daring and enterprise which at one time threatened most serious results. Their guns, too, were admirably served; and although night found the British, masters of the field, yet, when morning dawned, both armies seemed to hang back from a renewal of the contest, though continuing to face and defy each other at a respectable distance, until the successful issue of the siege of Mooltan having liberated another British division, alarmed the Sikh commander into activity, for, suddenly turning Lord Gough's flank, with the design apparently of seizing Lahore, and perhaps marching on Delhi, he was promptly followed up, and eventually brought to bay at Goojerat, where a final and decisive battle terminated the career of the Sikhs as an independent power.

Goojerat was in fact little more than an artillery duel on a gigantic scale. For upwards of two hours the guns of both armies, about two hundred in number, pounded each other with incessant fury until those of the enemy were silenced. Then at last the veteran British chief, who had meanwhile curbed his own impatience and the impetuosity of his troops, saw that the fit time had come to let slip the dogs of war, and soon the whole Sikh army was in precipitate flight, leaving 56 guns on the field. Promptly followed up by Sir Walter Gilbert's flying column, 16,000 men, the sole remnant of the great Sikh army delivered up their arms and the remainder of their guns on the plain, and the war was at an end; and thus was the last great danger which threatened British dominion from without, removed.

As the best safeguard for future tranquillity, the Punjab dominions were permanently annexed to the British Indian Empire; the young Maharajah, Dhulleep Sing, being liberally pensioned. A board of administration was formed, whereof the late Sir Henry Lawrence

was president. Prompt and vigorous measures were taken to disarm the population, and every inducement offered to their leading men to turn their swords into ploughshares and their spears into pruning-hooks; while an outlet for the martial tendencies of the military classes was afforded in several new local regiments on the irregular system, and in sundry police corps, which it was deemed politic to raise for the defence of the northern hill frontier, and for the preservation of internal order.

In a marvellously short space of time, this land, so long the theatre of misrule, turmoil, and violence, settled down into a state of calm, if not contented tranquillity. A new stimulus was given to agriculture and commerce, new roads and canals were opened out in all directions, and a tide of prosperity and improvement set in, which has been steadily on the increase up to the present time, and which even the troubles of 1857 did but little to interrupt.

The new Punjabee regiments, composed partly of Sikhs and partly of Mahomedans, with a sprinkling of Hindoos and Goorkhas, and subjected to the wholesome discipline and intelligent guidance of picked English officers, proved a most successful experiment. The new force soon established, and has since maintained, a first-rate reputation for efficiency and fidelity; and those same soldierly qualities which had rendered them the most formidable of foes, elevated them, when enlisted on our side, to the highest rank of merit in the Native Army of India.

In 1858 the Punjabee troops in British employ mustered, according to parliamentary blue-books, not less than 75,000 strong, of whom about 54,000 were irregulars, and the rest spread through the police. About one-third of the whole were Sikhs, and two-thirds Mahomedans. As far as I have been able to ascertain from the authorized Army Lists, the present available force of Sikhs and Punjabees in our military service consists of only about 20,000 men, independently of those scattered over the old sepoy regiments under the new organization. They are distributed as follows:—

In the Punjab frontier force and guide corps, about	10,000
In the Bengal Native Infantry under the new organization	10,000
Total	20,000

Of these I should think less than one-half are genuine Sikhs, the rest being Northern Pathans; hence it will be seen that the number of these born warriors enlisted in our service has undergone a vast reduction since the year 1858, so that we can scarcely be said, at the present time, to have any to spare for service out of India, unless indeed by raising new regiments to meet such a call from without. Should British India ever be invaded from the direction of Afghanistan, we could muster no better or sturdier soldiers (besides those of our own country) to meet the foe than those very Sikhs and Pathans of the Punjab, among whom border warfare has for centuries been a normal condition of existence. The Sitana campaign of 1863 against the mountain tribes north of the River Indus proved how admirably

these troops are adapted for the defence of our frontier in that quarter. Sir Neville Chamberlain, in his despatches, has borne ample testimony to their fidelity and devotion, and although many of the Pathans engaged on our side on that occasion belonged to the very same tribes which were fighting against us, yet there was no instance of desertion or of backwardness in engaging the enemy.

It has been already remarked that the Sikh derives those distinctive qualities wherein his excellence as a soldier chiefly consists from his religious system. To what extent those influences which have heretofore operated in forming his character may be modified by the altered political circumstances of his condition remains to be seen; but it seems highly probable that the dispersion of the race over a wider surface, and the enlarged intercourse thereby established with men of other creeds, will gradually effect, if it have not already effected, a considerable change in that respect. It is notorious that the majority of those Sikhs who had entered the old Bengal sepoy regiments before the year 1857 joined with the mutineers, and fought against us at Delhi and elsewhere; although it is but just to mention that a faithful few, foreseeing the plot in preparation, took their discharge before the outbreak. On the other hand, all those attached to purely Punjab regiments, and separated thereby from the evil influences of disaffected Brahmins and Mahomedans of India, proved faithful to their salt. This fact assuredly seems to afford ground for believing that it may be our safest policy to keep our Punjabee soldiers in separate nationalities for the future. Hence, too, it may be doubted whether their wide dispersion over the Indian continent may not, by too closely assimilating them to our other subjects, operate injuriously, though by slow degrees, in depriving them of those special characteristics which we have found heretofore so valuable an ingredient in their composition. Indeed, I have been assured by an officer very recently attached to a Punjabee regiment quartered in the Western Provinces, that indications have not been wanting of late of a tendency on the part of some of our Sikh soldiers to relapse into the old caste prejudices of the Hindoos around them.

After Runjeet Sing's death, there being no strong master mind to exercise a controlling influence over them, the Sikh battalions repeatedly rose in mutiny, killing both European and Native officers indiscriminately, and it is highly probable that the example then set was not without its mischievous results on the minds of our own sepoys. But looking at the Sikhs as we ourselves have found them, rather than as they were apt to be under the exciting and degenerating influences of an unsettled Government, it must be admitted that we have ample grounds for confidence and trust. All who have seen them on active service agree that, whether employed as irregular cavalry, under such leaders as Probyn and Fane, or as light infantry on the irregular footing, they are not to be excelled. As artillerymen, their reputation stands equally high, but it has been our obvious policy since the lesson taught us by the mutiny, to keep our guns, with a few special exceptions, in the hands of our own countrymen, and Sir John Lawrence has well remarked that, "No mutiny of a native army, without guns, could

hope to be successful," guns being an object of intense fear to the natives of the East, and for that reason objects also of adoration to the Indian gunner.

Punjab soldiers will cheerfully march on the shortest notice wherever ordered, and have always been described as patient under fatigue and privation, and readily rallied in case of a reverse. No apter illustration of their readiness of resource under difficulties can be given than that recorded by Mr. Herwald Wake, C.B., in his public report of the celebrated defence of Mr. Boyle's house, at Arrah, when a gallant little band of English residents, assisted by 50 of Rattray's Sikh military police, successfully defied for a whole week three mutinous regiments from Dinapore, under the great Behar rebel Koer Sing. Mr. Wake thus writes :—" Every endeavour was made by the rebels "to induce the Sikhs to abandon us; heavy bribes were offered to "them, and their own countrymen employed as mediators. They "treated every effort with derision, showing perfect obedience and "discipline. During the entire siege, which lasted seven days, "every possible stratagem was practised against us. Incessant "assaults were made upon the bungalow. Not only did our Sikhs "behave with perfect coolness and patience, but their untiring labour "met and prevented every threatened disaster. Water began to run "short; a well 18 feet by 4 was dug in less than 12 hours. The rebels "raised a barricade on the top of the opposite house; our own grew in "the same proportion. A shot shook a weak place in our defence; "the place was made twice as strong as before. We began to feel "the want of animal food; a sally was made at night, and four sheep "brought in; and finally, when we ascertained beyond a doubt that "the enemy were undermining us, a counter mine was quickly dug. "On the 30th July the troops sent to our relief from Dinapore were "attacked and beaten back. On the next day the rebels returned, "and telling us they had annihilated our relief, offered the Sikhs their "lives and liberty, if they would give up the Government officers."

In acknowledgment of these signal services the Government promptly advanced the native officers a step in promotion, and bestowed on each officer and man a twelvemonth's additional pay. The whole corps has since been embodied as an integral part of the Bengal Native Army, under the name of the 45th Bengal Infantry. A detachment of 150 of these same Sikhs shortly afterwards joined my own small field force, for the attack of Koer Sing's jungle stronghold at Jugdespore, and thus I had an opportunity of personally witnessing their conduct before an enemy. What struck me most was their light-hearted cheerfulness, almost amounting to joviality, even under fire; the jaunty springiness of their step on the line of march, and the elasticity of their whole demeanour under fatigues and trials which usually cause dejection in men of other nations. They evidently loved fighting for fighting sake. One very prominent trait in their character I very soon discovered to be, their love of plunder, or "loot" as it is called in India. The day after the capture of Jugdespore, I was suddenly summoned to quell a violent quarrel among the Sikh officers, in the course of which they had actually drawn their weapons, and threatened to proceed to ex-

tremities. I found that it originated in the discovery of some hidden treasure (about 20,000 rupees, or £2,000) regarding the partition of which they could by no means agree. Strictly speaking, they had no right to appropriate it at all, but, as matters stood just then in India, it would have been inexpedient to enforce that view, and it was quite sufficient for me to hint that if any further disturbance took place, I should solve the difficulty by claiming the treasure as common prize for the whole force, to allay their angry clamour, and they were soon restored to perfect good humour, as though nothing had happened to ruffle them.

Many other instances might be mentioned equally illustrative of the valuable qualities of the Sikh and Punjabee soldier. In the last Chinese war it is well known that the Sikh regiments acquitted themselves with signal valour in the field, and gave entire satisfaction in quarters; and it scarcely admits of a doubt, that whenever called upon for any special service, whether in China, Persia, Egypt, New Zealand, the Cape of Good Hope, or even in Europe itself, they would be found, if under equally good officers, equally manageable and effective. But many serious objections present themselves to the mind when considering the question of their employment out of India in time of peace as an integral portion of the national army of Great Britain; and I must confess that, to me, such an extension of their sphere of employment, at all events beyond the confines of Asia, except in special cases of emergency, as already suggested, appears a matter of very doubtful expediency. I believe that the oath taken by Punjabee recruits (both Sikh and Mahomedan) binds them to "march wherever directed, whether within or beyond the Indian territories;" but I apprehend the latter condition could only be intended to imply some urgent necessity of war, rendering such service indispensable for the security of the empire. Therefore their employment out of India in time of peace could only be fairly brought about, either by their volunteering for the purpose, or by Government raising a distinct force under new conditions, specially for colonial service. But, one striking characteristic of the Punjabee soldier is said to be that, while ready to start to the world's end at a moment's notice in search of adventure, and with the exciting prospect of fighting and plunder, he is less easily reconciled than even the Indian sepoy to a prolonged absence from his home and land, and when once the temporary excitement is over, is apt to get restless for a furlough. It therefore seems not improbable, that however flattered he might feel at the confidence reposed in his fidelity, he would, when the novelty was over, become impatient of his banishment, and heart-sick at the utter isolation his new position would entail; and such feelings, finding vent in his letters, might operate unfavourably on the minds of his countrymen at home.

I know it has been urged in favour of such a scheme that it might help in some degree to open the eyes of our native subjects to the enormous power and widely spread dominion of England, and to convince them of the hopelessness of struggling against our sovereignty in India. But I feel no great confidence that any such good would really result. If stationed at one of our colonies, they would

obtain but a very limited insight into the secret of our power, and would find but little to dazzle their oriental imaginations. In fact, compared with what they had already seen in India, everything connected with their own profession would appear on an absurdly small and insignificant scale. Even in England itself it is to be feared the reality would fall very far short of their pre-conceived ideas. Of the regal splendour of a court, and of the "pride, pomp, and circumstance of glorious war," they would after all see nothing to compare with one of the Governor-General's grand durbars, or field-days, such as recently took place at Agra; while, on the contrary, they would, in the ordinary course of a barrack life in this country, constantly witness things irreconcilable, to their uneducated minds, with oriental notions of real power, and inconsistent even with that moral superiority for which they might have previously given us credit.

Some idea of the erroneous impressions to which simple-minded Asiatics would be liable in this country may be gained from the following extract, taken from that most entertaining book, "The adventures of Hajee Baba in England," by Morier, which, though not literally true, is understood to give an accurate picture of the early experiences of the first Persian embassy in London. Hajee Baba, the hero of the tale, thus relates one of his morning adventures; the scene being a street in London during the Burdett riots in 1810, on the occasion of Sir Francis being taken a prisoner to the Tower: "I was quietly proceeding along one of the 'principal thoroughfares of the City, when I perceived a great mass 'of troops in full march, accompanied by several pieces of artillery, 'escorted by an immense mob of the dirtiest of the English, who 'were rending the air with abusive words, occasionally assaulting the 'soldiers with stones. I remarked that consternation appeared in the 'faces of some, whilst others appeared totally unconcerned. 'What-' 'ever is this?' said I to a man who had just stepped out of his 'house to see the sight. 'Oh,' said he, 'I believe they are going to 'take up a man.' 'Only a man!' said I, 'if you require this to take 'a man, what must you require to take a city?' I was so im-' 'pressed with this strange scene, that I thought no more of my 'private miseries, but immediately returned home in all haste. I 'felt that the ambassador ought to know the state of things. 'At 'all events,' thought I, 'at the risk of getting more blows on the 'mouth, I'll tell him into what a state this country has fallen, and, 'if the rebellion which has evidently begun is not put down, he'll 'see the necessity of providing for our safety.'"

I quote this story not from any supposed value attaching to it as a fact (for it may have been altogether imaginary), but as coming from a writer thoroughly versed in oriental character and modes of thought, and therefore not unlikely to be a correct representation of what might actually take place under the supposed circumstances. And, who can say that our unsophisticated Sikh soldiers might not be fated to undergo many such strange alarms if quartered here in England, in these days of Fenian outbreaks, monster processions, and political excitement, and that the tendency would not inevitably be to shake

their confidence in the power of our Queen, and in the stability of our Government? The natives of India can appreciate, and, above all things, reverence a strong Government; but a country seemingly governed by mob law, as, to their credulous and mistaken minds might sometimes appear to be the case with our own, would, I suspect, very soon cease to retain either their respect or obedience.

Judging then partly from my own experience of uneducated orientals, and partly from that of others, I should consider that a far more sound and salutary impression would be made on their minds by taking a telescopic view of our greatness and grandeur from a distance, through the medium of the imagination, than by a microscopic inspection of our littlenesses at close-quarters. As a general rule, all orientals, but especially the uneducated among them, when brought face to face with civilized life, are like fish out of water, and I see nothing in the character of our illiterate Sikh soldiery to induce me to believe that they would form an exception thereto. But, independently of all this, it can scarcely admit of a doubt that the employment of foreign Asiatic mercenaries of this description within these realms would be utterly repugnant to the feelings of the people, and opposed to the spirit of our institutions. No doubt, the martial and picturesque appearance of a regiment of Sikh cavalry at a review in Hyde Park, or forming part of the royal escort down Parliament-street, would excite the enthusiastic admiration of the mass of spectators and especially that of the ladies, and would convey to the minds of foreigners some just notions of the military resources of our Indian possessions and of the physical capabilities of their war-like populations; but I very much question whether all this would reconcile the British public at large to such an encroachment on their cherished rights and prejudices, as the presence of these strange guardians of the peace would involve.

There is, in short, but one mode in which an opening of this sort might be made, devoid of the objections already mentioned. An experiment on a small scale would be amply sufficient, and this would consist in selecting annually from the whole native army about half a dozen native officers of distinguished service and of superior intelligence as temporary Aides-de-camp to the Queen, to be attached to army head-quarters in England, except when required to attend upon Her Majesty on state occasions. Of course an English officer, conversant with their language and customs, should be attached to them. To men thus conspicuously selected and honourably employed, a year in England would be one continuous fête, and some good might possibly result from their favourable reports to their brethren in the east. A wholesome spirit of emulation might thus too be kept up among the whole body of native officers, and one probable result would be an anxiety to acquaint themselves with the English language and literature, of which they are at present wholly ignorant. The proportion from each Presidency should be as three, two, and one, for Bengal, Bombay, and Madras; for it should be borne in mind that there would probably be other candidates for such an enviable honour besides the Sikhs. I more especially allude to the native officers of

the Scinde Irregular Horse (formerly so well known as "Jacob's Horse"), a body of much longer standing, who fought our battles in Persia and elsewhere with signal credit, who never once wavered in their allegiance, and who are, perhaps justly, considered by their own officers as the very *beau ideal* of soldierly excellence and loyalty.

Should, however, this country be involved in war, in Persia, Egypt, or any other quarter which might threaten the British power in the east, there need be no question about the employment on any such field, of such Indian troops as the Scinde and Sikh Irregular Cavalry, and the various regiments of Punjabee, Sikh, and even Goorkha infantry. Or, should Russia really threaten our north-west frontier, obliging us to drain our colonies of English troops to meet so formidable a foe, it cannot but be satisfactory to know that we might, for the occasion, substitute in all such localities as might be willing to receive them, as many native troops of the above description as could best be spared at such a crisis, although it must be remembered that all these troops, even if specially raised for the purpose, would be necessarily officered by properly qualified English gentlemen belonging to the Indian Staff Corps and local services, who would of course carry with them their rights and privileges, and I apprehend this might give rise to some difficulties and complications which have been apparently ignored or lost sight of by most advocates of the scheme. But, until such an emergency shall arise, there seems to be no particular object in altering the arrangements already existing for the protection of our colonies with British troops, unless indeed the present difficulty in enlisting recruits for the English army should unhappily cripple our military resources to such an extent as to render such aid from India indispensable.

In this latter case we might certainly substitute, even in these peaceable times, regiments composed of Punjabees or Goorkhas for some of the British regiments in China, Ceylon, Mauritius, New Zealand, and the Cape; although I consider there would be always a certain amount of danger in leading our Indian subjects to suppose that England had exhausted her own stock of soldiers, and was becoming dependent on her native Indian army for the defence of her widely-spread possessions in other parts of the world. And this leads me to another branch of my subject, viz., the continued maintenance in India of the present large European force, consisting entirely of Her Majesty's line regiments, and numbering 70,000 strong.

It was foreseen by many from the first, that there would in a few years be found a very serious practical difficulty in carrying out the amalgamation of the armies which took place in 1861. In that year I myself thus recorded my own opinions in an article written for the *Friend of India*:—"In April, 1857, the total European force in India mustered 42,179; according to the lowest and most recent estimate, its future strength must be maintained at somewhere about 73,500. Thus the annual drain on our home population will be henceforth nearly doubled. Meanwhile, the conditions of military service have, by virtue of amalgamation, undergone a material change. Whereas formerly a term of service in India was regarded by a soldier of the

"Royal Army as only a possible contingency, which it might or might not be his fate to undergo for a limited period, it must in future be considered by the majority as an unavoidable certainty, for which every recruit would do well to be fully prepared on first enlisting." And now, after six years' experience of the new system, I find it broadly asserted by a writer on our "Home Defences," in *Macmillan's Magazine* for February, "that India is a bugbear both to officers and men."

The writer in *Macmillan* proposes, as the best remedy for the evil, that we should retrace our steps, and go back again to the old system of a local European army; but another talented writer on the same subject in *Blackwood's Magazine* for the same month goes further still, and would, to quote his own words, "separate absolutely and by an impassable gulf, colonial and Indian service from home service." He would have not only India, but our colonies all over the world, "provide for their own defence in peace time, just as they, in other respects, manage their own affairs." "As to India," he adds, "it is rich enough to hire again, as it hired of old, as many European troops as are necessary to form the backbone of a great military power." This writer considers that the European army of India need not exceed in number 45,000 men, with a reserve in England of 15,000 men, making a total of 60,000 men. He argues that, "in assigning a garrison of 70,000 Englishmen to British India, we are attempting too much. The drain upon our youth is heavier than it will stand, and greater than the necessities of the case require."

There is indeed evidence enough on all sides that a vast change of opinion has come over the people of this country, without regard to party, since the amalgamation took place; and that if the reconstruction of our Indian armies were now, as then, under consideration for the first time, it would be very differently carried out. But to recede in legislation is always an unwelcome task. Nevertheless, the difficulty is one that presses upon us more and more year by year, and must be grappled with and overcome, and that soon, if we would retain our position as a great power in the world, and the integrity of our empire in the East.

It is perhaps presumptuous in me to differ from the admirably expressed views of the article in *Blackwood*, wherein it is easy to trace a master hand: but the present seems a favourable opportunity for suggesting what seems to myself a more simple and favourable method of dealing with the question of again localizing an European force in India, without violently upsetting the present order of things in that country; and here I will venture to remark that India is a dangerous country in which to be perpetually trying new experiments. Our native subjects are keen observers, and very apt to mistake our irresolution for weakness. Scarcely six years have elapsed since we abolished the old system of a local army, and ever since then we have been perpetually making changes, until the whole military fabric of India has become a gigantic patchwork, or, in poetical language, "a mighty maze," I wish I could add, "but not without a plan." There is indeed not so much one plan, as a multiplicity of plans, which

have been hastily combined to form one confused and incongruous whole.

In fact, there have been too many cooks at work, and the wonder is, that so little mischief has been done, and so much real good been effected. If I offer myself to swell the number of cooks, I can only hope that, amidst the confusion which reigns in the establishment, I shall find myself not altogether "out of place."

I consider, then, that it is neither desirable nor expedient to cut asunder the link that unites the armies of England and of India; on the contrary, I would unite them still closer. India is our great school for officers, and above all, for generals; where Clive, Lake, Wellesley, Combermere, Sale, Gough, Napier, Havelock, Clyde, Strathnairn, and a host of other illustrious men* obtained their most valuable lessons in the art of war, and where scores of promising officers are still learning to emulate their brilliant achievements. Were the officers of our home army separated by an "impassable gulf" from service in India, they would necessarily lose the benefit of that admirable school, and must fall back on such lessons as they could acquire at Aldershot and the Curragh, which, I fear, would prove a very inefficient substitute.

If, then, the experience of the past six years has really proved the present system of supplying India with European troops to require modification, as so generally asserted, I think a very salutary change might be effected without the separation of any limb or the intervention of any gulf. My plan for that purpose would be very similar to one which I proposed in 1859 in the *Times* of that period, and of which the late Sir Howard Douglas made favourable mention, as "deserving of consideration," in his last essay entitled the "Defence of England," published in the following year.

I may mention, at starting, that should the idea broached in *Blackwood's Magazine* of a local force for each colony ever find favour with the Government of this country, it would greatly facilitate the practical working out of my own scheme as regards India, which country is held by us on a footing so wholly different from that where-with we retain our colonies, that a system applying very well to the one would probably be found quite inappropriate to the other. Such important and self-supporting countries as Australia and Canada have now become, with a large and ever increasing European population, consisting chiefly of emigrants from the mother country, may well be able to raise and support efficient local armies for their own defence in ordinary times; and should such an arrangement ever take place (as I conclude must be the case sooner or later), the sphere of duty for the English army will be very greatly curtailed, and our ability for maintaining an efficient European army for India will, in proportion, be largely increased. No doubt, too, the completion of the railway system throughout India will eventually enable us to hold that country with

* I purposely omit from this category such well-known names as Pollock, Nott, Outram, Malcolm, and many others who achieved their world-wide reputation as officers of the Indian local army.—V. E.

fewer European troops, provided the railways themselves be effectually guarded by a dependable body of mounted police, with rallying points at certain intervals, and the sooner some well-devised plan of protection is organized for that purpose the better; otherwise this anticipated new source of strength may, in reality, prove only one of weakness.* Meanwhile, it is obviously expedient that we devise some system whereby a prolonged service in India may be rendered more attractive to the mass of our soldiers.

I will now quote that part of my original scheme which, I venture to think, might still be made applicable, with a few modifications, to the present time:—

"The attention of British statesmen has of late been fairly aroused to the necessity of providing effectually for our home defences against the possible dangers of invasion. During the perils that recently beset our Indian empire every available regiment was sent out, until England and her colonies were almost denuded of troops, and it was deemed expedient to raise several additional battalions (about 24, I believe) for home service, to supply the deficiency until the pressure from without should cease. But, as by general consent, the safety of India demands the maintenance there of 60,000 to 80,000 European soldiers, whereof it is proposed that about one-third should be locals, there seems every chance of the aforesaid additional battalions being maintained as an integral part of the British Army. They are at present, however, considered as temporary excrescences, under the designation of second battalions of certain regiments of the line.

"My proposal is to alter their constitution in such a manner as to dovetail with our local force in India, or to have in their stead a certain number of permanent 'garrison battalions' expressly for home defence, and to raise a corresponding number of 'Indian battalions' expressly for local service in India; the former to act as recruiting depôts for the latter. The system of promoting by seniority should, I think, prevail in both these local services alike, and exchanges should be freely allowed between them. (Indeed there need be but one cadre of officers for both battalions, which would effectually prevent any difficulty on that score.) Under this system the home battalions would be at once recruiting depôts and nurseries for our Indian regiments, and arks of refuge for our veteran heroes after the latter have undergone a sufficient quantum of exposure and buffeting in India. By this reciprocity of interests both countries would be

* In a very timely volume on the "Military Questions of the Day," published since the delivery of this lecture by Lieutenant-Colonel Sir Henry M. Havelock, Bart., that officer urges the extensive employment of "European mounted riflemen" to supplement our railway system in India. Such a force, he says, "would, by constantly patrolling, keep the railways intact from being torn up, a duty which neither British infantry nor native cavalry could perform equally well. The railways would help to forward the mounted riflemen, horses and all, rapidly to the point from which their own special movement would begin; each branch of force would thus help the other. But without mounted riflemen, a widespread system of railways, not being capable of being properly guarded, might prove a delusion and a snare, rather than an aid in military operations against insurrection."—V. E.

"gainers; India would gain a constant succession of healthy young soldiers, ready disciplined and prepared to do credit to our country and service in the east; while England would obtain for her own defence a constant supply of home-sick, yet still efficient and valuable veterans experienced in war, with medals on their breasts, and loyalty in their hearts, to stimulate their younger brethren, and 'show how fields were won.' Each service would take a pride in and reflect a glory on the other; the successes of either would be causes of triumph to both, and thus would the army of India be indissolubly wedded to that of England, by a never-failing of mutual interests and mutual regard.

"Thus too would the India local service again attract the better classes of recruits who now hold aloof, and would at once attain a *locus standi* sufficiently distinguished to inspire its own members with pride, and the sister services with respect.

"I see nothing in this scheme but what is practicable and advantageous to both countries and both services. It can scarcely be needful to point out the manifest advantages that would be secured for the mother-country by maintaining a permanent local force for home defence. It might be made to consist almost wholly of veterans who have already established some claims to comparative tranquillity at home. Such a body of men and officers in cases of real emergency would, from their experience in war, be found fit guardians of their native land, and would inspire in all around them that calm and happy confidence which is so often the harbinger of victory."

Such, then, is the outline of my scheme, and should the principle on which it is based be admitted as correct, I feel assured there would be no insuperable difficulty in carrying it into practical execution. That principle is, in fact, simply one of DOUBLE REGIMENTS, which, like the Siamese twins, should be connected with each other by an indissoluble link. It would be found equally applicable to our colonies, since each colony might have its own local force with its representative regiment at home. It already exists in the artillery, which, like a gigantic banyan tree, has its parent trunk permanently fixed at Woolwich, and its family ramifications all over the world, with "Ubique" for their common motto. At all events, I venture to offer the scheme, such as it is, for the consideration of any brother professionals and of my countrymen at large, without entering into further details that might be wearisome to my present audience.

Before concluding, however, I would ask permission to offer a few remarks on another kindred subject of some importance to our European soldiers in India; and here again I will quote from a paper penned by myself while in India six years ago, for I feel that it still expresses, as forcibly as I am able to put it, a most important question which cannot be too often or too perseveringly urged on the rulers of this country, viz., "the question of military colonization."

"Must India," I ask, "continue to drain the life blood of England and expend the thews and sinews of her sons for the maintenance of our power in the east, and yet are we never to take root in the country

"we hold at such a costly sacrifice?—The time has arrived when we must awake from the lethargy of a century and avail ourselves to the utmost of the advantages which, for wise and beneficent purposes have been placed within our reach. Now or never we must begin to plant the available offshoots of our European population in the positions best suited for their healthy and vigorous growth.

"If we are continuously to pour the living mass of our standing line army into India as a necessary portion of its service, we must devise means to make the country more attractive to the soldiers of that army than it has heretofore been. We must open to them a career, with a hopeful termination discernible in the distant perspective.

"Let, for instance, every British regiment in India have its colonization fund; let every soldier be made to feel the pleasant assurance that by husbanding a portion of his pay in that fund, and by establishing for himself a character for sobriety and good conduct, he will stand a fair chance, at the expiration of his service, of settling with his wife and children in a permanent home, on land provided for him by the State on certain conditions, and subject to military regulations, in a community of his own countrymen, selected like himself for good character, and with the means, if he choose to avail himself of them, of earning by the sweat of his brow, or by whatever useful acquirements he may have mastered, a decent competency for himself and family.

"To ensure success for such an experiment, strict selection with respect to individual merit and personal fitness for the work, must be the invariable rule whereby to regulate the admittance of a candidate to a colony. Each regiment should furnish periodically a list of candidates so qualified, for the information of Government.

"In addition to the above tests, the knowledge of some useful trade or handicraft, the possession of sufficient pecuniary means to supply the pecuniary requirements of a settler's life, and general aptitude for the peculiar condition of a colonist, should be taken to account.

"For the first experimental colony begun on any such plan, a sufficient number of worthy candidates would, I believe, be forthcoming without difficulty, at the call of Government, to act as pioneers of civilization, should any really sound and practical scheme for military colonization be set on foot by competent authority. I use the term 'military' advisedly; convinced that the principle it involves is essential to the success of any colony founded in India, for it implies that all important *something* without which the best soldiers very soon degenerate into a disorderly rabble. Soldiers who have been accustomed for many years of their lives to go like carriage-horses in harness, would often feel absolutely helpless without a driver; and there are few gregarious situations in life where human beings, whether they be soldiers or civilians, are collectively concerned, in which *discipline* would not be found a decided advantage.

"Therefore, should the superintendent of each colony be a retired officer of the army, and one who understands something of European soldiers; let him be vested with plenary magisterial and special

"powers, and be competent, both by character and position, not only to command respect, but also to enforce obedience.

"To those who would pre-judge and condemn, such a project as 'quixotic,' I say, give it at least a fair trial! In other countries we English have proved ourselves eminently successful as colonists, and so far from the antecedents of a soldier's life disqualifying him for such a career in the temperate and hilly tracts which abound in India, I maintain that under wholesome restrictions, he is more likely to succeed than an unlicked clodhopper or an unbridled artizan. The one great evil to be avoided is drink. Let only steady sober men be selected, and let the strictest rules be enforced against drunkenness, even to the extent of imprisonment and expulsion."

About the very time when I was thus earnestly urging on the attention of the ruling authorities in India the arguments you have just heard, it so happened that another officer was engaged, quite unknown to me, in drawing up a most ably written article on the same subject for the *Calcutta Review*, wherein he entered very fully into the practical details necessary for carrying out a complete scheme of military colonization in the hilly and temperate tracts of India most suited for the purpose. Although dated a little prior to my own paper in the *Friend of India* that number of the review was not actually published until a month or two later, and it was most encouraging to find my own views shared in, if not anticipated, by a writer who had evidently devoted much more attention to the practical minutiae of the subject than myself, and who seemed to possess all the ability requisite for carrying out such a project. I have only very recently been assured that the writer of that article was Captain Knollys of the 93rd Highlanders, whom I believe to be now in England, and I hope he will kindly pardon the liberty taken with his name by an entire stranger, and that he may be encouraged to persevere in the noble task so zealously entered upon six years ago, and which deserves the cordial support not only of every soldier's friend, but of every man who wishes well to the permanence of our rule in British India. It is pleasant to me to reflect now, that I did my best to draw public attention to his project, of which I trust we may soon hear more full particulars from himself. Meanwhile I cannot do better than repeat here the last paragraph of my own review upon it in the *Friend of India*, which is equally applicable now as then. "The entire article is worthy to be read and seriously pondered over by those who guide the fortunes of India, and who now have a noble opportunity of initiating a new era, big with future promise, in the Government of the country under British rule. To them and to our statesmen generally we commend the early consideration of this great question. With a hopeful progeny of infant colonies around us, we shall at last begin to believe that we really have, like the Emperor of the French, a destiny."

In the Journal of this Institution for October, 1866, will be found two admirable lectures, delivered in this room on the 4th and 11th of May last, by Dr. Mouat, on the "British Soldier in India," containing much valuable information on the facilities that exist for such military colonies

as I am now advocating, and referring to my own slight efforts in 1861 to pave the way for their introduction. From some correspondence which took place in India on this subject, between myself and the Commander-in-Chief, Sir Hugh Rose, now Lord Strathnairn, I have good reason to believe that his Lordship would be found friendly to any movement in this direction which might now be set on foot in this country. The time seems more favourable now than then. Waste lands are more easily available for Europeans; the rapid extension of tea, coffee, and cinchona plantations in the hills has already caused an influx of European settlers to a moderate extent. The cultivation of those plants involves no very hard labour, and would afford suitable out-door employment for old soldiers, under competent guidance. Why, then, should not a beginning be made at once, under the auspices of the Government of India, and thus let it be known far and wide among our recruiting districts throughout the United Kingdom that, amid those healthy and magnificent mountains, whose glorious summits of perpetual snow are visible from a distance of more than 200 miles, and which overlook, like giant sentinels, the rich and populous plains of India, presenting an irresistible barrier of strength and security to its inhabitants, let it be known, I say, that in that most beautiful region of the earth is perched, high above the debilitating influences of tropical heat and miasma, ready for the reception of our brave soldiers after the toils of active service are at an end, nor for themselves only, but also for their children after them, that long yearned-for desideratum, a "SOLDIER'S HOME."

I must now conclude, asking pardon of my audience if I have trespassed too long upon their patience. The importance of the subjects which I have so cursorily treated, rendered it difficult to condense what I had to say into smaller compass. I only trust that this, my slight labour of love, in behalf of an Army wherein I have spent so many happy years of my life, may prove not altogether devoid of interest and of profit.

Ebening Meeting.

Monday, April 29th, 1867.

VICE-ADMIRAL SIR HENRY J. CODRINGTON, K.C.B., in the
Chair.

NAMES OF MEMBERS who joined the Institution between the 8th and
29th April, 1867.

LIFE.

Keppel, W. A. H., Lieut., Norfolk Militia Artillery.

ANNUAL.

Bancroft, W. C., Major 16th Regiment. 1l.	MacGregor, C. M., Lieut. H.M., Bengal Staff Corps. 1l.
Terry, Frederick S., Captain 25th K. O. Borderers. 1l.	Hamilton, T. Bramston, Lieut. Royal Horse Artillery. 1l.
Dampier, C. L., M., Ensign 25th K. O. Borderers. 1l.	Worcester, H. A. W. F. S., Marquis of, Cornet Roy. Horse Guards. 1l.
Hutchinson, A. J., Ensign 23rd R. W. Fus. 1l.	Dundas, Lawrence, Cornet Royal Horse Guards. 1l.
Brackenbury, Henry, Captain Royal Artillery. 1l.	Hardie, H. B., Lieut. Haddington Militia Artillery. 1l.

LESSONS FROM LISSA.

By Commander P. H. COLOMB, R.N.

It was well observed by a writer in the "Saturday Review" last year—from whom I have taken the liberty of borrowing a modified title—that "the moral of the great Prussian victory" of Sadowa "has been dwelt upon so constantly by the press of every European country, as almost to throw into the shade the not less striking lesson to be gathered from the Italian defeat in the waters of the Adriatic." Indeed few of those who are accustomed to look without prejudice on the great military and naval questions of the day, can have avoided a feeling of surprise that the great sea-fight of Lissa produced so small and so evanescent a commentary at the hands of persons qualified to deal with it. For it is impossible, on mature reflection, to avoid the

conviction that the battle of Lissa is, beyond all bounds, the most important naval occurrence since the great day of Trafalgar. Whether we regard the nature of the forces engaged; the manner of their employment; or their magnitude; we cannot fail to be struck with the thought that the great experiment for which all maritime nations waited, has been tried, and that the path which naval warfare will in future follow, is no longer hidden in the mists of controverted opinion.

The bombardment of Algiers, and the battle of Navarino, the operations of the combined fleets during the Russian war, which, taken as a whole, bear a certain professional value—altogether fade in importance before the combat in the Adriatic. No naval man can turn to Algiers and draw thence a professional lesson applicable to the present day. He may watch and admire the example of consummate daring there displayed, but he must reflect that bravery is born in the soul, and does not come from outward schooling. We may all recollect how the false analogy of Algiers was used by the press as a goad to stimulate the supposed want of enterprise of our Admirals during the Russian war; and the futile attack on the sea forts of Sevastopol may warn us of the uselessness of accepting superficial teaching.

The battle of Navarino, between the forces of advancing and retrograding powers, begun without plan and continued without combination,* serves as no model for our imitation.

The operations conducted by the western navies during the Russian war, with ships only partially embodying modern improvements, in exceptional situations, against exceptional opposing forces, how shall we draw from them any elements by which to guide ourselves in future wars? But more than all, we must carefully reflect that such a sweeping change has passed, or is passing, over modern navies, that the chain which has bound us to the past may easily be assumed to be broken; if any links remain, we may be sure they do not lie immediately on the surface, and it must be weary, and may be unprofitable, to follow too closely any analogy offered by former naval battles to what is assumed to be their future conduct.

In one respect the battle of Lissa is probably of insignificant proportions. Its political effects were overshadowed by other dominant circumstances; and should it secure an influence in that sphere, which it does not now possess, few will be able to trace that influence to its source.

The position I assume in attempting to draw out for discussion, what appear to me the salient points of this battle, is a very simple one. I wish to look on the battle entirely as one for scientific examination. In this Theatre we have nothing to do with the *argumentum ad hominem*, and therefore praise or blame shall not escape from my lips, nor will it, I hope, escape from those who may take part in the discussion. We may the more easily avoid this dangerous ground by reflecting that the Lessons from Lissa are not to be drawn from the

* This remark simply refers to the fact, that until fire was opened, it was not known whether there would be a battle; and is no reflection on any Officer concerned. May 14.—P. H. C.

consideration of any political necessities which directed an attack on a fortified island in the presence of an intact floating force; nor are they to be drawn from the personal characters of those in the respective fleets, or one might also say from their personal conduct, except in so far as it concerned the application or disregard of certain purely scientific principles, which I hope to make plain to you in the course of this paper. Again, the path is comparatively easy to us, if my opinion be correct, that the real lessons of the combat are to be drawn entirely from that part of the battle comprised between the near approach of the Austrian fleet and the sinking of the "Re d'Italia," a period extending over a comparatively short portion of the three hours and a quarter, said to include the whole battle from first to last. I must beg your indulgence, if, in referring to a paper of mine read in this Institution previous to the battle of Lissa, I seem to ask you to view me in the light of a true prophet.* It is in a manner obligatory on me to quote from it as forming a link in my chain of argument, but I wish to be understood as referring to it simply as I would refer to any other writings which answer the same end. I shall not go into any details respecting the battle, because such are quite unnecessary for my purpose, and also because I believe we are to have the historical record drawn out for us by very much abler hands than mine. But in order to get at the lessons taught us, I must mention the broad features of the battle, and I shall, at each stage, make what appear to me the reflections properly raised thereon.

The Italian fleet, consisting of four completely iron-plated ships, seven partially so, one turret-ship, seven wooden frigates, and fifteen smaller vessels, left the Italian ports chiefly on the 16th of July, 1866, for a concentrated attack upon the Austrian island of Lissa. This attack actually commenced on the 18th, and continued throughout the 19th, with varying success. On the 20th the ships were gathered on the northern shore of the island with the intention, should it be possible, of effecting a disembarkation to the westward of Port San Giorgio before the arrival of the Austrian fleet.

Meanwhile, the Austrian Admiral Tegethof, had been lying in Fasano roads at the head of a fleet composed as follows:—Seven iron-clads, one wooden line-of-battle ship, five frigates, and thirteen smaller vessels. He had early received intelligence of the impending attack upon Lissa, but at first considered it as a feint, having for its object to draw him from his base of operations. A telegram, however, reached him on the 19th, which no longer left it open to doubt that a real and persistent attack was intended upon the Austrian island; and about noon he put to sea with his whole fleet, having apparently fully made up his mind to save Lissa or be himself destroyed.

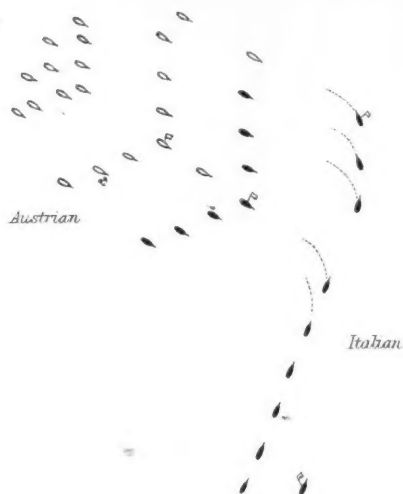
The Italian fleet received news of this movement, on the same evening, but it was hoped that the disembarkation and capture of the

* "Modern Naval Tactics;" see *Journal of the United Service Institution*, vol. ix., page 1.

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Commencement of the Battle

Fig. 2



Position of Italian Fleet when Austrians were signalled



Position of the Fleets at end of the Battle.

Fig. 4.



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Fig. 1.

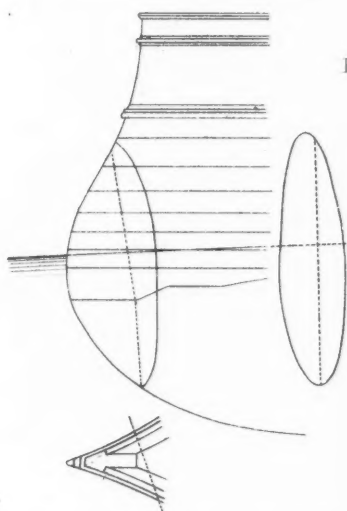
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Bow of the "Ferdinand Max" after collision with the Re d'Italia.

Fig. 3.





island might be concluded before the approach of the Austrians, thus releasing the Italian fleet to meet them.

The morning of the 20th July broke stormily and wild, the wind from the S.W. with heavy rain squalls. The arrival of a battalion of marines in the "Piemonte," decided Persano to push the final attack with all speed, and the necessary orders had actually been given, when at about 8 o'clock the "Esploratore" which had been stationed to look out in the N.W. quarter, re-appeared from a passing rain-squall which had hidden her, with the signal flying announcing suspicious ships in sight.

The position of the respective fleets appears at this moment to have been as follows. The Austrian steering S.E. by S. at a moderate speed, was in three divisions astern of each other. Each division was in the angular formation, or what it is now proposed to term "two quarter lines," as shewn in fig. 2 (plate v.), the angle formed between the two wings of each division was very obtuse, so much so as to give the Italians the idea that the ships were in line abreast. The divisions were about 1000 yards apart, and in the rear of each was a small ship for repeating signals.

The Italian fleet was in a scattered state along the northern shore of Lissa (fig. 1). Of the eleven ironclads, two, the "Terribile" and "Varese," were at too great a distance to the westward to be in time to have any important influence on the approaching combat. A third, the "Formidabile" had suffered considerably in the previous day's bombardment, and was fully engaged in transferring her wounded to the hospital ship. This left nine ironclads in a position to meet the approaching seven of the Austrians. The Italian wooden ships were closer in shore, engaged with the impedimenta of disembarkation. These ships took no material part in the affair, and adhering to the rule I have laid down, there being no particular lessons to be derived from an examination of their proceedings, it will be sufficient thus to account for their absence from the main part of the action. It is perhaps advisable to recollect, that while the Austrian fleet was complete with coals and ammunition, and the crews were fresh and intact, the Italians had had a large expenditure of the former necessities, and had suffered a loss of 16 killed and 95 wounded, while their crews were probably harassed by the previous day's bombardments. The forces which were really about to fight the battle of Lissa were, therefore, on the Austrian side:—7 ironclads, not of first-rate model, with an aggregate burthen of 27,200 tons, an aggregate power of 4,750 horses, a broadside of 88 guns, and 2,884 men.

On the Italian side were:—9 ironclads, all of new construction; of greater speed and generally of heavier plating than the Austrians; a combined tonnage of 38,500; a power of 6,000 horses; a broadside of 103 guns; and about 4,000 men.

Now, from a comparison of these forces thus ranged against each other, I think we may fairly derive our first and most impressive lesson. On one side we have 103 guns opposed to 27,000 tons; on the other, 88 guns opposed to 38,000 tons. The destructive work cut out for each gun was, therefore, on the Italian side, 262 tons; and on the Austrian, 432 tons.

Now, the Austrian tonnage, distributed as we should have seen it previous to the introduction of ironclads—allowing about 3,000 tons to a 90-gun ship—would have been represented by 9 of these ships carrying a broadside of 405 guns. The Italian tonnage, distributed in the same manner, would have been represented by 12 ships, carrying a broadside of 540 guns. The destructive work cut out for each Austrian gun would have then been 93 tons, in place of the 432 mentioned above: and the work cut out for each Italian gun would have been 50 tons, in lieu of the 260 before mentioned. That is to say, the Austrian guns should have been nearly 5 times, and the Italian guns, *more* than 5 times as destructive as those usually employed in two-deckers, in order to leave the artillery at the battle of Lissa in the position it had held as a weapon previous to the introduction of ironclads. I need not increase the force of this remark by pointing out that, while the mass to be destroyed was five times as great as usual on this occasion, the submerged and therefore invulnerable portion, was also greater than usual. No one will, I imagine, venture to argue that the artillery on either side at Lissa, far from exceeding the destructive capacity formerly attributed to guns, even approached it; and I think we can hardly exaggerate its enormous disproportion to the work it was supposed to do. But a wider question is raised by this simple examination. The proportion of work cut out for each gun at Lissa happens to be a fair example of what guns in any ironclad action will be required to undertake. If artillery is to retain its former destructive power, each gun must have a capacity for destroying ironclads at least five times as great as that possessed by the old patterns, for destroying wooden ships.

I have, I am sorry to say, never witnessed the effect of modern shot against modern ships' sides, and am not going to attempt to prove relative destructive effects, when shot strike. I merely take this as a first reflection suggested by the battle commented on, namely,—that without taking other elements into consideration than the number of guns relative to tonnage—either, each of our guns must do five times as much work as they used to do on wooden ships, or they have lost ground as weapons of war; and I may add to this, that an increase of 400 per cent. in the power of a gun is a heavy proportion to admit.

In considering the relative forces which were about to meet in action, we have to add to the Austrian side the wooden 92-gun ship "Kaiser," and her consorts, frigates and gun-boats, carrying a broadside of 177 guns. Had these ships been armed with guns capable of piercing the Italian plates, there might have arisen some difficulty in estimating their force; it being necessary to balance between their offensive powers and their extreme liability to injury, as evidenced by the fact of the "Kaiser" suffering two thirds of the whole Austrian loss. Their heaviest guns being, however, only capable of throwing a rifled shot of 60 lbs. weight, almost powerless against the Italian ships, we cannot be very far wrong in considering the Austrian wooden ships a source of weakness rather than of strength.

Perhaps this is the place to refer to another lesson from Lissa on

the question of unplated ships with heavy guns, *versus* armour plates. I have seen it several times in print, and I have heard it often seriously argued by naval officers, that the battle of Lissa shewed the value of wooden ships against ironclads; and the "Kaiser" has been on such occasions quoted as having beaten off a combined attack of four of them. Granting she did this, what but her evident weakness invited such an attack? and what was the ultimate result of all her gallant endeavours? She was so near destruction that she was obliged to haul out of action. She lost her bowsprit, foremast, and funnel, had 22 men killed and 83 wounded; more than two thirds, as I before said, of the loss suffered by the whole Austrian fleet. In return for this damage, she tore away the boats, bulwarks, and port-lids, of the "Re di Portugallo" by collision, and riddled the upper works of the "Affondatore" by shot; when we have said this, we have perhaps said all. I cannot, therefore, see how we are to place anything whatever to the credit of wood *versus* iron plates in consequence of what occurred at the battle of Lissa. It is argued on this question that we may, by reducing armour-plating, replace the weight so taken away by adding to the number of plate-piercing guns. But I think it is forgotten that for every plate-piercing gun carried by the non-plated ships, the plated one may carry several light shell-guns of terribly destructive powers when opposed to unplated scantling only. As an extreme case we should then have a totally unclad ship, whether of wood or iron, carrying a few plate-piercing guns, against a completely clad ship, armed with a multitude of light shell-guns, such, for instance, as the Armstrong 40-pounder. The power of the respective ships when in opposition would then be the number of rounds fired per minute, multiplied by the effective work done by a single shot. As the number of light guns carried, would be at least five or six times the number of plate-piercers, whilst the rapidity of fire would be possibly doubled, the question to be decided by those who argue in favour of non-plating would be:—Can you secure that each plate-piercing projectile shall do ten times the damage on the plated side of its opponent, that such opponent's shell will effect on the non-plated side? I think I am fairly understating the question in favour of the non-plated side, and it will be most interesting to hear from any qualified gentleman present, an estimate of the relative effects of the two species of ordnance quoted, against their respective targets.

I have stated, and illustrated by a diagram, the position of the two fleets when the approach of the Austrians was signalled by the Italian look-out ships. (Fig. 2.)

Persano formed his nine ironclads in line abreast with their heads to the westward, but afterwards passed into line ahead, steering about N.N.E., a course leading directly across that of the Austrian fleet. The Italian admiral now considered it advisable to shift his flag from the fourth ship in the line, the "Re d'Italia," to the "Affondatore," so as to better assume the command of the whole fleet. Admiral Persano has been much blamed for making this change. I will not presume to offer an opinion as to its prudence or imprudence at such a time, but if I be asked whether I consider the admiral is better placed as part of

his battle formation, or as detached from it—then I can only here repeat the portions of my former paper referring to that point, and say the battle of Lissa has therein taught me no new lesson.

I said in my paper on Modern Naval Tactics, that—"If a general on land were restricted as an admiral is at sea, to the use of signals for the conveyance of his orders he would place himself where he could best see and be seen. . . . I take the view that in future naval actions the Commander-in-chief will not take a position in the line. He will place himself in some swift, quick-turning vessel, not unarmed or unplaced, but still a light ship—the flag-ship of the future—where he can best view the movements of his own and the enemy's fleet, and where his signals can be at once perceived from all quarters." I recollect that expression of opinion was received by the meeting with considerable approval, and I am sure we should all be glad to hear whether that approval is still given to the idea. If the "Affondatore," with her smaller tonnage, is assumed to have been a much handier ship than the "Re d'Italia," we may express an opinion on their relative values as flag-ships, and on the relative values of the positions, out of the formation, and forming part of it, without allowing ourselves to be drawn away from those points, by other considerations affecting the judgment of the Italian admiral.

The two fleets—the Austrian steering S.E. by S. or thereabouts, and the Italian N.N.E., neared each other so rapidly that Tegethof had no time to make a signal, which he had prepared after the manner of our own Nelson, "as a fillip" to his fleet, but was only able to order the divisions to keep their distance at 1,000 yards apart; the ships of the divisions to close and go full speed; and finally to the ironclad division to bear down and sink the enemy. The respective positions of the fleets are given in the diagram, fig. 2. "Thus on the one part," says the article in the *Revue des deux Mondes*, which in spite of denial is still attributed to the Prince de Joinville, "we see the Italian squadron in a thin line, of the depth of a single ship only, drawn out to the length of 5,000 yards, presenting their broadsides to the enemy. On the other, the Austrian squadron in a compact mass closed up to a breadth of 1,200 yards, rushing upon the enemy at full speed with the advantage of wind and sea, to pierce him through and through. Such was the opening of the battle." Having brought the fleets into this position, I must again ask your indulgence while I quote from my previous paper, when I had imagined the results of a combat which Lissa realised in a great measure. I said, "But in order to set aside any lingering affection we may retain for the old line-of-battle as a fighting order; let us just recall the fact, that the serious part of a future naval attack does not appear to be the guns, but the rams. How will they affect the question? If we look into the history of all our naval actions, the decisive victories were gained, only when we succeeded in breaking through the enemy's line. The closest possible line-of-battle was the safest possible position, and an opening therein was hailed with joy by the attacking party as an earnest of success. . . . But suppose an admiral in a steam fleet, some ships of which are rams, can we not well imagine his exulting in the certainty

of victory the moment he saw a close line-of-battle neatly drawn up in the most convenient position possible for the action of the new and terrible weapon? The enemy could never be so foolhardy as to attempt such a proceeding; the approach of the rams would surely break up the line, for no captain would allow himself to be fairly run into when he could avoid it, and thus the great aim and end of all our great naval leaders would be obtained even before the action commenced."

Now I know I run a risk of being accused of egotism in making these quotations, and I could sincerely wish that some one else had used my words so as to have left me more free to deal with them. But the lesson I draw from the fact of such language having been used in this Theatre a year before any practical experiment took place, is so important that I cannot suffer any false delicacy to stand in my way. Officers present at the reading of my paper, might easily themselves have been placed within a few months in the position of the Italian officers at the battle of Lissa. Officers of rank who listened, might have had—and may still have to decide—what they will do with ships under their command, when their look-outs shall signal "The enemy in sight." The first question is, Can we not by close examination of *facts* distinctly establish the basis from which we must work? And next, Have we established such a basis?

Now as to the answer to the first question: has not what was stated by me—simply, as a naval officer who had given some study to the subject—shewn most clearly that if the tactics to be employed, "could not," to use Captain Selwyn's remark upon my paper, "be decided till the first action is fought," it was yet comparatively easy to say what was *not* to be done? I see nothing in any direction now, but absolute condemnation of the Italian line-of-battle as opposed to the Austrian attack. But I did not notice that my distinct condemnation of that formation for the purposes of defence, met with a reception sufficiently marked, to assure me that there was anything approaching to conviction on the subject in the minds of my hearers. I will go farther, and say that even now, in spite of the strong condemnation which is levelled at the Italian movement, the tremendous consequences involved in the abrogation of the line-of-battle as a fighting order, are hardly even considered, and the whole question is treated by a majority of the naval world as one of no moment! I have met with but one paper which clearly adverts to the matter; this is a very remarkable sketch by the French Admiral Touchard, in the January number of the *Revue Maritime*. I do not commit myself to all the details of his opinion there given, but it was curiously strengthening of my own, to find their echo in so independent a source.

It has been said that maritime warfare is in so changeable a state, that even supposing the principles of attack and defence could be clearly established to-day, some new invention or combination might to-morrow overturn them. This statement is made the excuse for avoiding the study of the question, for it is said that our minds might become trammelled by belief in certain theories, which, if true at the time of their birth, might be untrue when it became necessary to put them in

practice. Now it must be admitted that there is some reason in this argument. There is every danger of our committing ourselves to a theory which will not serve our turn when the time comes. If our minds were a perfect blank on the subject, and could be kept ready for the reception of a new idea, when it was absolutely mature and ready to be implicitly followed; then we should perhaps be wise to lie by and wait for this complete arrangement of true principles to be presented to us. But unfortunately our minds are by no means blank on this subject. If we do not displace them by some theory of attack and defence more fitted to modern facts, we shall certainly pin our faith to the methods followed by our forefathers with materials altogether different.

The question is not whether we shall lie by and watch the signs of the times ready to bend them to our purposes on the outbreak of war; but whether it is wiser for us to go into action with our heads full of the tactics of Rodney, St. Vincent, and Nelson; or to come to questions of attack and defence with our heads full of what appear to be the strong and weak points of our modern arms.

As regards the changes in tactics produced by changing weapons; it must be recollected that these changes are not sudden, violent jumps, without any warning. They are, every one of them, matters of cause and effect; and I do not for a moment doubt the possibility of sketching out beforehand the *direction* in which changes may be expected to occur. Our Navy is not celebrated for prescience in material changes, and it is for this very reason that I would insist on more study being given to methods by which a greater approach to prescience may be attained. The establishment of a theoretical basis founded upon the most recent knowledge, is one of the first requirements of progress in physical science. It is not necessary that this theory should be true to make it valuable; but it must include and explain all known facts, and will be modified from time to time, as new facts arise, or perhaps exploded altogether when some truth comes to the surface which cannot be embraced by it, so in matters of professional science we must have theories to fit our known facts. If we cannot attack and defend ships according to some previously arranged theoretical basis embodying all we know of the facts we have to deal with, we may find ourselves mastered by some one who *is* able to do so. We exist as a Navy on the understanding that we know how to attack and defend ships in the best manner, and the best manner can only be ascertained by the establishment of a theoretical basis such as I have spoken of.

The answer to the second question, have we established such a basis? can only be a decided negative. So little study has been given to the question, that there are few of our superior officers whose opinions coincide; and certainly the Service generally cannot be said to hold any opinions at all on the subject; and I own that I should feel the greatest alarm for the honour of our flag if a maritime war arose in which it was engaged, while opinion was thus vague. If ever there was a battle where theory carried the day against no theory—it was Lissa—and if we gained from it no other lesson than the necessity for a theory—it would be one quite important enough for our reflection.

I think it is plain enough that in assuming the line-of-battle as a formation in which to receive the Austrian attack, Admiral Persano had not displaced his old ideas of naval attack and defence, by any theory founded on the changed conditions of the naval service, and I have been told that curiously enough the question of the power of the ram as an element of naval warfare, was debated, much to its disadvantage, by the Italians previous to their sad experience of it. Time was, when I, in my own mind debated with the same result, but I am aware now that I had given it very little real thought.

We may now return to the proceedings of the respective fleets. The leading Italian division opened fire on the Austrians—it is said at two hundred yards,—but it is evident that the range must have been considerably greater, for the Austrians were going at least ten knots, and would therefore pass over the two hundred yards in forty seconds, and they yet had time to return the fire. On neither side was any important damage done, and the Austrian leading division passed through the Italian line between the third and fourth ships. As the Austrians touched none of the Italian fleet in their passage through, it is evident to me that there was a considerable gap between the third ship, the "Ancona," and the fourth, the "Re d'Italia." I notice in the Italian plan of the battle, that the interval between these two ships is made a little larger than between the others, but as seven ships, say nearly in line abreast, passed through that opening, the difference must have been more than a little. Two probable things account for this difference—first, that the "Re d'Italia" had originally eased her engines to allow the "Affondatore" to come up, and had not yet recovered her position; and, secondly, that the interval was purposely made by the "Re d'Italia" to avoid being run down by the Austrian ships. I have not seen it distinctly stated anywhere, but I put it to my hearers whether this is not a perfectly simple explanation of the harmlessness of the Austrian attack by rams in the first instance? It will doubtless occur to you here to require an explanation as to how the Austrian ironclads, bent as they were on running down their opponents, should have actually passed through the line at a point where there were no ships to run down! Again, a very simple and significant reason is at hand—they were returning their enemies' harmless fire by one equally futile, and were in consequence blinded and confused by the smoke of their own guns!

The position of the fleets was now as follows:—The Austrian in a still unbroken and compact mass, had divided the Italians into two separate parts. Three ships were on their port hand under one admiral, and six on their starboard hand, under the commander-in-chief. The firing seems to have become pretty general, and concerted movements were over for the present. The three Italian ironclads naturally turned to port to attack the weaker wooden Austrians, and the Austrian ironclads as naturally turned after them. The fleets being in this position, the Austrians having interposed their concentrated mass so as to separate the Italian divisions, it is the proper time to examine closely the causes which brought about this state of affairs;

the strategic effects of the position in the combatants; and the lessons to be drawn from the circumstances.

I have noticed that in most quarters where the battle has been spoken of, the particular formation assumed by the Austrians—the division in two quarter lines—is not considered to have contributed much, if at all, to the result attained. In this opinion I fully coincide. In my former paper I endeavoured to point out that however valuable in theory as an attacking formation, this angular figure might be, it was so unwieldy and so difficult to maintain, that practically it was valueless. Since I gave that opinion I have had opportunities of making experiments in an actual fleet, with the fullest confirmation of those views. Such a formation can only be maintained by means of extraordinary attention, and speedily becomes obliterated by a slight change of course. But when I spoke of the theoretical strength of the formation, I, and those who had preceded me, were only dealing with the fire of artillery. Its value had not been considered when used as a form of attack by rams. I think at the outset we may condemn it safely from this point of view. If a body of rams is to be moved as a whole, and to attack as a whole, it is of the first importance that the formation assumed by them should possess the maximum of mobility, which we have seen the angular formation does not enjoy. In an attack by rams, there are I conceive, two distinct objects, either of which may be sought for. You may use the indirect effect of the fear of being run down so as to break the enemy's fleet into two parts, to place your own between them, and to concentrate by that means your whole force upon half the enemy's. This might be compared to an attack by column amongst troops. And the formation in fleets to assume, would be one resembling such a column: one not presenting a wide front, but having considerable length. The other attack by rams would be to employ their direct effect and to destroy the enemy's ships by actual collision. This attack may be compared to a bayonet charge on shore; and the proper formation for fleets must evidently be one analogous to the line. Little depth and a wide front.

The angular formation assumed by the Austrians was a sort of compromise between the two opposite formations, and, such compromises being usually failures in war, may it not in some degree account for the failure of the direct attack by rams as far as we have gone? The indirect effect was however secured. An inferior fleet armed with inferior guns, by the indirect action of a hitherto untried weapon, had broken the line of an enemy altogether superior in ships and guns, and had attained, almost without a casualty, the object which in ancient days was considered equivalent to victory! Is not such an occurrence worthy of our closest scrutiny? Shall we not be neglecting our plainest duties, as Naval Officers who may have the honour of the country placed in our hands, if we omit making every reasonable endeavour to view this extraordinary circumstance in its true light?

It is generally said, and it certainly saves the trouble of thinking, to continue to say, that the Italians ought to have stopped the Austrians

by their fire; that their gunnery practice was so bad, that no data can be drawn from the fact that they did not. Gunnery it is said, was sadly neglected by the Italians previous to sailing for Lissa. At any rate the crews were newly raised men, who naturally could not be good gunners. Now I have not the slightest objection to receive this argument, provided those who thus account for the affair will begin at the right end. Unfortunately for my own peace at any rate, I have only found the argument stated thus: "The Austrian fleet advanced, and passed through the Italian, almost without receiving a scratch; *therefore* the Italian gunnery was bad." I should have accepted it perhaps had it stood thus: "It was known that the Italians placed so little reliance on the use of their new guns that they neglected to exercise them, and the badness of their practice was manifested in two days continuous firing on the forts of Lissa, *therefore* this must be taken into account with after occurrences." The argument thus stated, I have looked for in vain, but have met instead with the statement that the Italians placed extraordinary reliance on their guns, and that, as I have said, the question of "*guns versus rams*," was one debated, and quite settled in favour of the former by the Italian officers. I also know that a sufficient impression had been made on the Lissa forts to raise hopes of their capture. These things bring to my mind the question—"Allowing the gunnery of the Italians to have been somewhat deficient, could it by approaching perfection have stopped these unruly Austrians in their career?" Then there arises another point. The Italians were not armed entirely with plate-piercing guns, so that should we decide that they *could not*, even with perfect gunnery drill, have stopped the Austrians, it may still be argued that they would have succeeded, had they been completely armed as the "Bellerophon" or any of our most modern types of war ships. It becomes therefore better on the whole, that we should leave the actual, and come to the hypothetical, in order to draw our lesson.

The question to be argued is this, Can you, with a fleet of Bellerophons and the most highly-trained gunners, being in the position of the Italian fleet, stop another fleet of Bellerophons coming down upon you in the position and with the intentions of the Austrian fleets, by means of your artillery fire? This is the great question which the battle of Lissa calls upon us to decide. Perhaps none of us are aware of the extraordinary importance of a right decision and a speedy one. To my mind, it enters—shall I say as an *intrusion*?—into all our schemes of construction and armament, and raises uncomfortable doubts which I should only be too glad to put aside, but not being able to do so, must come here to share with my hearers, or to have them put aside for me.

Let us just reflect a little what the consequences may be, should it turn out that what I asserted in my former paper, and what Lissa confirmed, is actually the truth? Namely, "that the serious part of a naval attack is not the guns, but the rams." The very least harm which can come to us, is another of those expensive reconstructions of which we have had enough experience, while the limit of inconvenience is drawn sufficiently wide to include any amount of dis-

aster in the first naval war, through dependence on a weapon whose day is past. There is no ship in the English navy built or fitted on the understanding that her guns are to perform a subordinate part in her offensive operations, but there are suggestive models to be seen here and there, which may warn us of what is possible, supposing this great question of rams *versus* guns, should be settled by practical experiment in favour of the former.

Before entering on our specific examination of what may be predicated of the meeting of our two hypothetical fleets, let me just put some general considerations before you, which I have nowhere seen commented on, but which appear to be deserving of the most careful weighing at the very outset of the question.

I have said that without other elements than the tonnage of ships, compared with the number of guns carried, the artillerist must shew that his gun can effect five times the damage on its iron target that its predecessor could on its wooden one, before he can claim to hold his own even so far. If we add rapidity of fire, as another element, we shall find it all against the guns. If we add accuracy, we find it still to depend on the accuracy of the human eye, and the steadiness of the platform, and do not thereby put much to the credit side of the guns. If we add range, we find it valueless without increased accuracy. So that the artillerist is left to prove not only that his shot *when it strikes* shall do five times the old damage, but shall add to it damage enough to make up for loss by decreased rapidity of fire. But if we bring the ram in as part of the equation, we find the gun retiring still further from its position. However we arm our ships with guns, whether on the broadside or turret principles, or on a combination thereof—one thing will remain certain, that the best position for delivering the fire, will be broadside on to the object. But if the object be an approaching ram, the best position for attack by guns, is the worst position for receiving her. Again, a ship to use her ram in the best manner, puts herself end-on to the object to be attacked. But if the object be a ship defending herself by artillery fire, this end-on position is the best for receiving it. For it is no longer as it used to be in this matter; "raking broadsides" are not now to be dreaded. A ship end-on, offers the smallest target to the enemy, and gains any advantage there may be from presenting her plates at an angle to the line of fire. She is however in the worst position for using her guns. Let us see what she gains by so depriving herself of them.

That which creates all the confusion of a naval battle, is the smoke; that part of it which most confuses any particular ship, is her own smoke—not her enemy's. If I, at the distance of a few hundred yards from my enemy, fire my own guns, I cannot for a minute or two see what my enemy is doing; at best, I have but a confused idea of it. If my enemy covers himself with the smoke of his guns, but I abstain from so covering myself, I can quite clearly make out *his* movements, while I know he must be doubtful about mine. If, therefore, I wish to run him down, I shall hope to see him envelope himself with smoke as soon as possible. If I *could* use my guns—which I cannot, being end-on to him, both to receive his shot in the safest way, and also to give him

my stem in the speediest way—I should still not use them, because it would prevent my seeing my way clearly. Will his ship meantime do me fatal damage? We shall examine that point shortly. At present we stand thus:—He, to use his guns, places himself in the worst position and under the worst circumstances for receiving my ram. I to use my ram, place myself in the best position and under the best circumstances to receive his fire! These are very broad and simple considerations, I cannot of myself escape from their lessons by any bye-paths.

We may return now to our two fleets, one in line-of-battle, trusting in its artillery, the other in a mass, trusting to its ramming powers under full speed. Will the artillery fire stop it?

Let us say the approaching fleet steams 10 knots towards the other, and that the fire commences at 2,000 yards. With the old smooth-bore guns it used to be our naval rule that 2,000 yards was 500 outside the range of effective fire, not because of any lack of destructive effect of missiles, when they hit, at that range, but because they so seldom hit. The slight increase of accuracy due to the careful construction and lower trajectory of modern guns may have altered the old rule a little, but I think 2,000 yards will be considered the extreme effective range. But just consider further, what such a distance means? It signifies that the defending fleet has only got six minutes to defend itself in, for in six minutes, at 10 knots, the approaching fleet will crash into it! Recollect, again, what this means with modern plate-piercing guns. It means that four shot, at the very outside, can be fired from each gun, whether they hit or miss. 28 shot from a Bellerophon at the bow of another Bellerophon, with a strong probability that if those 28 shot do not stop her, there will be a crash, a few cries, a heeling over to 45°, time to fire “just this last”—which does not hit—and we and our men, guns and all, go seeking the still waters a thousand fathoms down! This is no over statement against guns, for I find the mean of 65 rounds fired from 6 and 12-ton guns at a target, for speed and accuracy, under the most favourable circumstances, was 1m. 53s: between each round.

We must remember, in considering the chances of shot hitting or missing under the circumstances given, first, that the number of misses from improper elevation greatly exceeds those due to improper direction. If this is so at a steady target, how enormously must the disproportion be increased when the distance of the target is not only doubtful in the first instance, but is altering at the rate of more than 300 yards per minute. If the first shot were fired, as we have supposed, at 2,000 yards, the next would be at 1,500, the third at 1,000, and the fourth at 500. The elevations would commence at 4° 30', and would descend to 3° 15', 2° 6', and 1° 0'. Now if the rate of firing at a target whose distance is known and fixed be only one round in a minute and a half, is it an exaggerated estimate to say that the above circumstance will reduce it to one round in three minutes? Of course I speak of shot where some attempt is made to hit the object. Then with these two rounds per gun, instead of four, which could really be fired with any prospect of result, I must leave it to you to say, what

proportion you think will take effect. I have no means of calculating it, and I am not aware that any experiments have ever been tried to determine this most important question.

But so far as Lissa's lesson goes, I am quite confident that the best of gunnery on the part of the Italians would still have called forth those expressions of surprise from the Austrian officers at their immunity from danger. Those, however, who may take an opposite view, will certainly agree with me that we should ascertain with all speed, by experiments, what are our real chances of hitting an enemy who is altering his distance at so rapid a rate. The practice might easily be carried out with any ship which fires nearly in the line of keel, by running directly for a target at full speed, firing at it as rapidly as possible, and noting the results from the masthead.

In 1862, the effect of this connection of rapid motion with gun practice was commented on in a very able and practical little pamphlet, by Lieutenant Duncan Stewart. He says, speaking of some experiments of Admiral Martin in 1861, "I must confess I was greatly astonished "to find how few shots could be got at a ship whilst passing the one "I was in. It must be taken into consideration that there was no "smoke to intercept a clear view of the other ships—that there was no "firing upon the ship I was in, and consequently no confusion—that, in "short, everything was in our favour; yet so difficult did I find it for "captains of guns to get a shot in close action, that I am forced to doubt "whether it would not be advantageous to discontinue the practice of "extreme training, except at very long distances, and leave it to the "helm to keep the object within easy training of the guns pointed "abeam.

"A still greater difficulty than training arises from the rapid alteration of distance, and the consequent increase or decrease of elevation which the gun requires. . . . Let us suppose two ships "approaching one another at the rate of 10 knots each—that is, "diminishing their distance at the rate of 20 knots, or a knot in three "minutes. The two ships being a knot apart, would, in three minutes, "be into one another, if they so wished. The gunnery-book recommends that fire should not be opened, from the old or unrifled guns, at "a greater distance than 1,500 yards; therefore, in 2½ minutes, the "maximum distance recommended for firing would be traversed; and "this necessitates a progressive alteration in the elevation of 3¼° "or ¾° for every 100 yards. Now let it be borne in mind, that this "rapid change of distance has to be calculated by the eye, and "allowed for by each captain of a gun. It must be obvious to any "one, who knows anything of the state of a man-of-war's quarters, "that the distance of the enemy could not be communicated verbally "from the deck, so rapidly as to make the information available for "practice."

Now, taking all these considerations, general and particular, into view, I cannot escape from the conviction that our question,—“Can “the fleet, using its artillery, stop the other fleet proposing to ram at “full speed?”—must be answered with a most decided negative. I do not say that the action of Lissa proves it—but I do say that that

action brings to the surface, and forces us to argue out those questions which do prove it.

So far, then, I have no hesitation in saying that the break up of the Italian fleet, and the speedy establishment of the *mêlée* while yet the Austrians were comparatively untouched, were the natural results of the positions and ideas of the two fleets. The inefficient gunnery of the Italians, is beside the question.

So much for the causes which enabled the Austrian fleet to divide the Italian, and place itself unharmed in the interval. Now for the strategic effects of such an occurrence.

When the enemy's line was so broken in olden days, the attacker could concentrate his force on the weathermost ships without a chance of those to leeward getting up in time to save them. Steam has abolished this advantage to the extent that there are no physical obstacles to prevent the re-union of the divided fleet. We must not, however, imagine that dividing a steam fleet in two, is without strategic value, the moral effect of a few ships finding themselves suddenly cut off from their main body, and apparently surrounded by a superior force, will, generally, be great enough to induce an amount of hesitation and doubt in the minds of the officers commanding such ships, sufficient to make a considerable moral obstacle to re-union. We must never lose sight of the fact that humanity is made of such stuff, as rarely to be capable of acting well when the leader is suddenly withdrawn. And, if you can cut a few ships off from their Admiral, the mere fact of your so separating them, is many points to their loss and your gain. They are quite sure to be more undecided in their movements, more unsteady in their fire, and altogether more at your mercy, than if not so cut off. There are very few officers who know exactly what to do, and do it, when in times of excitement like a naval battle, an unexpected occurrence places them at an apparent disadvantage. Nelson, certainly, was not to be so foiled, but it was the very rarity of that quality which made it so marked in him. But neither is the Admiral who is cut off from his ships in a happy state, he may be quite ready to take the best steps possible under the circumstances, but he can have no confidence in being seconded by the cut-off ships, so that the strategic effects of breaking the line, are not to be despised even with steam.

But now, if the Italian fleet could not stop the Austrians, by their fire, under any circumstances, what steps should they have taken? This is the important question, which has not received any answer, but which I believe can be answered with thought. It involves however, the remedy, and Lissa only shews us, the disease; therefore, I do not propose at present to attempt the consideration of *that* lesson.

From what happened after the two fleets fell into confusion, until they separated, two incidents only, need be drawn forth for remark—the sinking of the “*Re d'Italia*,” and the firing of the “*Palestro*.” After several failures, partial rubs, and total misses, one Austrian ship—the “*Ferdinand Max*”—sees ahead of her a grey mass, she goes full speed at it and hits it fair. The shock to her, does not appear heavy

and does no damage; the huge grey mass, however, surges over 45°. The "Max" backs astern, and looks with somewhat of awful curiosity for the result of her blow. It is not long doubtful. The "Re d' Italia" tumbles back again. There is terrible confusion on board, for the water is roaring into her like a cataract. In two or three minutes the victim plunges heavily down, and leaves nothing to tell of her whereabouts, but a few shrieking, struggling remnants of her ill-fated crew of 600 men. 400 souls, they say, went with her to the bottom. Now, what lesson are we to draw here? simply that there is an end to the danger previously supposed to be incurred by the ram in striking. The "Max" ran her prow completely into the "Re d' Italia"—as shown in figure 3, where the lines represent the marks found on it after the battle—without any evil results whatever. There was no displacement or straining of her engines, nothing in short as a set-off against the terrible damage she inflicted. The power of the new weapon was conclusively proved, and it is henceforth impossible to doubt its practical value.

The lesson to be drawn from the firing of the "Palestro," may be viewed in two lights. First, it shews the necessity of getting rid as much as possible of all combustible materials in a man-of-war. Next, it proves the enormous importance of proper appliances for promptly extinguishing fire during action. The writer in the *Revue des deux Mondes* holds that the "Palestro's" disaster is absolutely condemnatory of partial plating. Agreeing in this view, I do not shut my eyes to the fact that plating can no longer keep out shells. But it must be remembered that though it cannot keep them out when they hit fair, it can reduce materially the chances of their hitting at all; for it necessitates heavy guns and few, in place of light guns and many. It is enough for us to know that the "Palestro's" death blow may have come from an Austrian wooden ship, and that such a blow would have been harmless had she been fully plated.

There is a suggestive lesson to be drawn from the fact, that after perhaps an hour and a half confused *mêlée*, the opposing fleets had passed through each other and re-formed, the Austrians being now in the position previously held by the Italians. Part of this result was doubtless due to the desire of covering Lissa, but I think it was also due to the power of movement preserved intact, and the natural instinct of concerted action, rather than independent combat. The Austrian charge placed most of their ships to the eastward of the Italian fleet at the first onset, and both fleets seem simply to have re-formed where they found themselves already massed.

We heard a great deal of the extent to which signals were used on both sides, when the early news of the battle reached us. I am inclined to think that signalling did not bear a very important part in this battle. There were, undoubtedly, a good many signals made on both sides, but mostly before and after the *mêlée*. There is no occasion for us on this ground to underrate the importance of signalling. I think that Lissa shows the value of concerted movement, and efficient signals are the only means of securing it.

It will be seen from what I have said, that I find myself obliged for

the present to hold that the gun, as a naval weapon, no longer keeps the first place. In my previous paper on "Tactics," I drew such a conclusion, but I was not then aware that the case is nearly so strong as it now appears to me. The *Revue des deux Mondes* does not support me in this view, but considers Tegethof had "an unheard-of piece of luck, of which he knew how to avail himself. In spite of the incontestable power of the ram, the gun still remains the chief arm, and rules Naval Warfare." Admiral Touchard however has no doubt about the matter. "The beak," he says, "is now the principal weapon in Naval Combats—the ultima ratio of maritime war."

Now, I think to speak of Tegethof's as an "unheard-of" chance is an utterance without basis. It was the first time the experiment of ramming had ever been made in the open sea. It broke up the Italian fleet to commence with, and it destroyed their finest ship in a few minutes; it won the battle, and yet was only an unheard-of chance!

Do not let us be led away by such an assertion. Let us carefully separate fact from opinion—remember that the latter goes to the winds before the former. How does the case stand? General opinion—even of the Austrians themselves—says, "Oh, ramming is such uncertain work, it can seldom succeed." Fact says it is so far uncertain that it wins the first battle where it is tried, it also says that, in the first six months of 1866, 1,924 ships were reported at Lloyds as having rammed each other to such an extent that 92 of them found it convenient to go to the bottom without further parley. And these nearly 2,000 ships which so succeeded in doing this difficult thing were all of them trying "how not to do it." Besides, who *knows* it is a difficult thing? Who has tried it and failed often enough to certify to its difficulty? The answer is, no one. There is a general opinion that is difficult in the teeth of the well-known difficulty of preventing it. The real fact I believe to be, that the "wish is father to the thought" in this matter. The consequences of the change of weapons are so revolutionary, that we decline to entertain the idea, and will do so till it is rudely shaken into us.

Admiral Touchard, comparing the attack by rams to a bayonet charge, believes, that such comparison holds throughout, and that the battle, commenced by artillery will be terminated by rams. I take exactly the opposite view. The bayonet charge resembles the attack by rams, more nearly in its moral, than in its physical effect. The nerve-disturbance effected by the rapid approach of a line of sharp pointed glittering steel is so great that, as we all know, its advent is seldom waited for. The opposing forces gaze for a moment, and break to fly for their lives. How the enemy's nerves will stand the rush of a line of rams at 10 knots, let those who have either been run down at sea, or have just escaped it, answer. But the bayonet charge only finishes an action on shore, because it cannot begin it. It cannot be delivered till the forces have pressed closely on one another, as a man can only run a certain distance before exhaustion takes place, and because the nature of the ground usually prevents it. Neither of these circumstances affect the sea-bayonet charge, and few who mean to win,

will hesitate to commence operations by at any rate disturbing the nerves of their opponents.

Let us also seriously reflect on the terrible moral effect of the sinking of a ship like the "Re d'Italia?" When the two fleets drew apart, Persano counted his ships. "Where is the 'Re d'Italia?'" he asked by signal. "Sunk!" flew at the mast-heads of several ships, as answer. Sunk! the ship he had left a couple of hours before. Sunk! his finest ship and 600 men! With no premonitory symptoms, no grandeur of fire and smoke like the "Palestro," then in flames. Only lying quietly at the bottom of the Adriatic, full of drowned men at their quarters, and an Austrian Fleet not far distant in perfect order, ready to send one or two more down to keep her company if need be.

Victory is gained, not by extermination of men or destruction of material; but by a moral effect produced on the minds of the survivors. In a fleet in action, the destruction of life in the interior of one ship by shot, has no moral effect on her neighbours, simply because they are ignorant of it. But send her to the bottom, or blow her up, and the effect thrills through every nerve—a matter of exultation to the winners, and of depression to the losers. As regards gaining the day, there can be no question, that the destruction of life by shot spread over the whole fleet, bears a very minor relation in the attainment of victory to the destruction of one complete ship and all that she contains. I think it must be remembered too, that capture has all but disappeared as an element of naval warfare. In the days of sailing vessels, when capture was imminent, flight was impossible. But now a ship will fly from the scene of action as a first measure, and will only haul down her colours if caught up afterwards.

I must now conclude this outline of the lessons which I imagine may be drawn from Lissa. No one can be more conscious of its many faults than I am myself. A strong conviction that the battle was a premonitory symptom of an extraordinary revolution in naval warfare near at hand—a conviction which grew as I sought to weaken it—made it almost a matter of duty on my part to put it into words. I have endeavoured to confine myself to indicating the causes which will produce these revolutionary effects. I may at some future time ask you to look closer still into the question, and indicate the measures I conceive will be necessary in order to be prepared for so great a change.

Shall I be deemed fanciful, if I mention finally some straws which are indications to me how the wind blows in the matter of guns *versus* rams? During my naval career, more wonderful changes have passed over the Service than have occurred during any other equal period of time. All these changes have been attended by one extraordinary characteristic. They had no sooner reached perfection than their death-warrant was signed! When I entered the service, the Naval world was wholly occupied by the great Symondite question. Sailing frigates, and their wonderful powers under competitive trials, experimental brigs, cruised in company, and attracted universal admiration by their completeness and perfection. But lo! no sooner was every-one satisfied that in the frigate and the brig we had really reached per-

fection, than a rumour began to spread that few more would be built, because the paddle frigate and sloop were the true "eyes of the Fleet." Then came the great question of the paddle frigate, which was no sooner solved by Terribles, Sidons, Retributions and Odins, than it became noised abroad that the screw was the true mode of propulsion. Then came the complete reconstruction of the Navy on the screw wooden-ships' principle, which turned out those magnificent specimens of naval architecture which we should be very glad to be well rid of at this moment. Then rose our iron-clad fleet, which is as yet so far from perfection that we need not fear for its stability. But if our ships have not reached that dangerous precipice, have we not reached it with our guns? Their wonderful powers, the perfection of the appliances for working them, are the admiration of the world. Having made little progress for centuries, they have suddenly jumped to a position undreamt of ten years ago. I hear them on all sides, and for the first time, spoken of in language and in terms such as I have heard used towards sailing frigates, brigs, paddle steamers, and screw line-of-battle ships. I remember that when the talk and controversy about sailing-vessels ran highest and hottest, there was a doubtful under-current pushing up Terribles, Sidons, and Retributions, which ultimately swallowed up the discussions and sailing frigates together. Then waxed the Service-talk strong on the subject of future Naval actions being fought by sailing line-of-battle ships, each with her attendant paddle steamer. The best means of taking in tow and casting off, and the rate of towing, were the great questions argued. A very small minority had seen in the "Rattler," and later in the "Amphion" and "Arrogant," an end of these questions through the near-at hand rise of the screw; but the mind of the Service generally was not at all turned in that direction, and even after the "Blenheim," a line-of-battle ship had, to the wonder of Portsmouth, *steamed* out of harbour, men still ridiculed the idea of a complete steam fleet. Then, opinion having tardily admitted that it was conquered by fact, we were building our finest specimens of wooden men-of-war, when a minority in the shape of a French Emperor discovered that the means of attack were terribly in advance of the means of defence in ships. "La Gloire" had her momentous birth—whose results are by no means ascertained—and her brethren and sisters are springing up in every direction. There is, as there always has been, in these changes, something like a nervous clutching of opinion—a sort of drowning-clutch I may say—at the idea of a restoration of at least a part of our wooden fleet. This we are prepared for, for we have always seen it. But when I look for the under-current pushing up the new thing, I find little distinction in the matter of build, little in the matter of propulsion, but I notice a confused buzzing about a new weapon—a certain half-hearted arming, sharpening and pointing of the stems of ships. Thinking over the matter, I observe that this stem-weapon is in a measure antagonistic to the other one—artillery. That at least, the ship fitted and handled best for one, will be fitted and handled worst for the other. Am I fanciful, if with my historical parallels hovering about me, I

further observe the gun question at its height, and see the precipice at hand?

Commander DAWSON, R.N. : As a gunnery officer, I suppose I ought to stand up for the guns. I am quite shocked to hear Captain Colomb, a gunnery officer himself, stand up and abuse the guns. With regard to the ram, I am not quite prepared to accept the doctrine that the ram is the new weapon of future war. There was a weapon which I expected Captain Colomb would have alluded to, and which I think will come to replace the ram in another generation. There is one thing observable in the action at Lissa, that though there was a determined attempt to ram on the part of several, if not of all the iron-clad ships on the Austrian side, yet there was only one successful result. I think that points to the fact of there being a great difficulty in hitting a ship; that, although the Italian iron-clads do present their broadsides to the enemy in the line ahead in the diagram, yet by a turn of the helm, they might prevent collision, or at least receive the shock in a better position than on their broadside. I think the ram question is open to great discussion; but I think, if you could introduce a system that would destroy by a graze instead of by ramming, it would be a more simple operation. Another point Captain Colomb deals with is, whether the Admiral should occupy a position in the line of formation, or whether he should be separated from it. I should have thought if there were one thing the "lessons from Lissa" have taught us, it is that the Admiral ought to be leading his fleet. I think the Austrians gained their success chiefly by Admiral Tegethoff being in the centre of his own fleet, and leading them by his own example. And I think the Italians may be said almost to have lost the battle because the Admiral was not where he ought to have been, in the centre of his fleet on that occasion. As far as the "lessons from Lissa" are concerned, that is one lesson, I think, we learn from them. What Captain Colomb says, with reference to the uncertainty of hitting a moving object, is, I think, undeniable, not only with reference to the motion of the vessel which is firing, but also with reference to the moving vessel aimed at. Most of our experience in gunnery has been confined to firing with very little motion; that is to say, with very little speed. We fire with rolling motion, but very rarely whilst turning rapidly, or moving with great speed. We seldom fire at a moving object. When I was serving at Plymouth, Captain Jerningham made some experiments in firing at a target in tow of a gun-boat going at full speed, and the result showed the difficulty of hitting an object which is going at considerable speed across the range. Evidently, if you are altering the range, and altering the direction of your vessel at the same time, it must be extremely difficult to make any accurate practice with guns. We must come to some more short and decisive weapon like the ram, if you can hit with it; but if you cannot hit with it, I should like to have some implement by which the enemy can be destroyed by a simple graze of your own ship.

Captain COLOMB: I presume Captain Dawson suggests that I ought to have mentioned the torpedo, which is the pet at present. But he should understand that I have been treating of "the lessons from Lissa." The torpedo was not used at Lissa. It comes only under the head of "remedy;" and I have been pointing out the "disease." If I come to treat of the remedy, I should certainly not fail to avail myself of such information as I can get from Captain Dawson on the subject. I may mention this, that when I, unfortunately, found myself deserting my old colours in the matter of guns, (which was a very unpleasant process to me,) I came, as a last resource, to the conclusion, that guns would be still the most important weapon in the attack on fortifications, even if we could not use them so much as we could wish against ships. Then some information conveyed to me by Captain Dawson drove that idea away, because I am quite unable to believe, on account of the extent to which the science of the torpedo is being carried, that our ships will ever be allowed to come near enough to destroy fortifications.

Commander DAWSON: The Italian fleet were kept out of Venice by the knowledge that stationary torpedoes were planted between the batteries.

Captain COLOMB: I think there can be no question about that: therefore, that is another point where the ground is cut away from under the guns in a very distinct manner. With regard to the Admiral leading his fleet, we must not mix

up two questions. There is the question whether the Admiral is better employed as part of his formation, or as not a part of it. The position that the Admiral may afterwards take up, is quite a different matter. I am not prepared to say that the Admiral should not on occasions lead his fleet in. But I think, if my anticipations are right, that a great deal of movement, and a great deal of combined movement, and a great many repetitions of what we saw in the Austrian and Italian fleets—that is, much passing and re-passing through the fleets should be a feature in future actions—I think it will be extremely desirable that the Admiral should not be part of his formation, not the pivot upon which his fleet is to turn. I think he would be better away from the formation. But what his position may be is quite another question.

The CHAIRMAN: I am sure the meeting will join me in giving our best thanks to Captain Colomb for a most interesting paper, a paper that gives one a great deal to think of for the future, as well as interest in the action at Lissa. There are one or two points I think we may touch upon in our remarks. First, I should like, if I may be personal myself, to set him right on one point he mentioned with regard to the battle of Navarino. I think he said there were not sufficient general preparations. Curiously enough, it was a battle in which there were more preparations than usual, inasmuch as it involved the question of preparation for peaceable reception and also preparation for possible war. The line was clearly marked out for a peaceable line going in. But at the same time for war there was every preparation made that the Admiral could possibly make, for the guidance not only of his own ship, but of every ship in his own squadron, every ship in the French squadron, and every ship in the Russian squadron. Singularly enough, every ship was furnished with a plan not only of the harbour, but of her own position marked out in it, and of the position of every other ship in the squadron; and not only of the allied squadron, but of the enemy's squadron. So it is very clear there was a great deal of preparation made there. Every ship went in with a full knowledge of the plan. I pass over this, having been personally concerned in it. I now come to remark upon one or two points. First of all with regard to the future position of the Admiral in the squadron. It is a very difficult thing to say which way it is to be. We have all a recollection of English history, of the way in which a British Admiral went into action, shifting his flag from one ship to another. In one action we read of this being done three times. Again, in later times, we have seen that an Admiral has shifted his flag, and has been enabled to superintend the action of his squadrons in two separate parts, a little apart from each other, better than he would have done if he had been all the time in one ship. But that was an action where those two separate parts were fixed, in action against forts. It would be hard to define a general rule to apply to all circumstances for an Admiral in action. One thing is perfectly clear, that wherever he may be, he should be in a position not only to make signals to his squadron, but also to show a good example to the whole of his squadron. The tactics of the Austrians and the Italians are open to various opinions. It is a very curious thing which we must remark upon, that only one ship was rammed out of all that fine charge. The loss of the other vessel was a matter of gunnery. Gunnery did one, and ramming did the other. It is curious that with the utmost intention on the part of those seven Austrian iron-clads, there was only one successful case of ramming. I am not surprised at it when they were in motion; but I am surprised at it afterwards, when they were in *mêlée*, that there was no opportunity given for the ramming ships when they were brought to a standstill. It appears to me that the most dangerous time for a ship is solely, when she stops, because, immediately when she stops after ramming another vessel, another ship can ram her and run her down. It would be difficult to make any tactics in a *mêlée*; and I think we must fall back upon what is analogous to the spirit of the service in our Navy, which I hope will long continue, namely, that every individual Captain should place himself in the spirit of his Admiral, and should be taught that he cannot do wrong if he goes right at an enemy's ship. He must be under certain general rules. If it were impossible before, to make signals very frequently in action, it would be much more impossible in the present day. We move far too quickly now. The vital blows of a battle will be given, comparatively, in a few minutes. There is no time for signals. Who that has ever seen a

squadron steaming along, and has known the difficulty of making out signals when there is no firing going on, can doubt the great difficulty of signals when an action begins? I must say the instructions of the Admiral should be given before the action is begun. His policy and the way the enemy shall be received should be settled beforehand; his Captains should all thoroughly know what his wishes are; and what they are to do in such and such circumstances, and without waiting for signals to put them into operation. There will be no time for making signals, whether the Admiral is in a swift steamer going about, or whether he is on board one of the squadron. There is no time for signals in a *mêlée*, and it is the *mêlée* which decides the battle. As to shifting the Admiral's flag, we must remember that this very unfortunate ship that was rammed at Lissa was the Admiral's ship, and the squadron might have suffered the discouragement of seeing their Admiral go down. So we cannot make a rule as to the way in which the Admiral should act. It strikes me as a very curious thing that, after the Austrians had passed, the Italians did not, if they possessed the same intention, ram the Austrians, exactly as the Austrians had rammed them. Looking at the matter, without any attempt to form any plan of tactics, I should think nothing could be worse than an extended line. I would rather see the squadrons in two divisions, a little apart from each other; and whichever division the enemy selected to attack, the other division should run into the attackers. These are crude ideas thrown out at the moment. We must think the subject over a good deal before we make any positive plan. I do not know anything that is more liable to be overturned, than any theory we can form of battles on general principles. One thing will last for ever; that close action, be it with our rams, or whatever it may be, is a system we must make up our minds to, as a thing more consistent with our English character, and more suited to it, than fighting at long range.

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